EDITORIAL

IRON AND STEEL AND ITS READERS.

Curious, but quite understandable, misapprehensions exist concerning the functions and meaning of a technical journal. To many, perhaps to the majority, a technical publication signifies merely that some misguided person believes there is money to be made in launching such an enterprise. It may be mentioned, also, that not a few professional men, men who really should know better, have a vague idea that the technical periodical is more or less parasitical. It were well to clear away at once these wrongheaded ideas.

The properly conducted technical periodical is an organic part of the professional body politic. It is not, and never has been, a very inviting venture from the investor's point of view. Indeed, it cannot become even self-supporting without the active assistance and continued moral support of its constituents.

What, it may be asked, constitutes the value of the technical periodical? This question is easily answered.

In the first place it is (always postulating the support of its constituents) the clearing-house of current technical thought. It is the forum wherein are debated and resolved the urgent problems of today, and wherein, also, is foreshadowed tomorrow's progress. It is the guardian alike of professional liberties and of professional ethics. The advance of industry and technology without such a medium is unthinkable.

It is obviously impossible for one man, or for any small group of men, to sit in editorial chairs and there distil and distribute wisdom drawn from their own intellectual reservoirs. But, apparently, this fact is only dimly apprehended by the busy member of the profession. No one, alas, is more painfully aware of these facts than is the poor and plural editor. Indeed, it is not the editorial conscience that needs awakening.

To be explicit, Iron and Steel calls upon its readers, both those of the laity and those of the profession, to send ideas, topics for discussion, records of events, and any and all matter that may stimulate thought and inspire debate.

To achieve this high aim, the intellectual energy, professional experience, ambitions and even prejudices of editors and readers should be syndicated.

Let us devoutly pray for this desired consummation.

OUR IRON ORES AGAIN.

In a paper presented at a meeting of the Toronto branch of the Canadian Institute of Mining and Metallurgy, Mr. R. H. Flaherty, one of the best authorities on iron ore deposits in this country, commented on the fact that it has long been the habit of Canadians to view our iron ores with scant appreciation and to exert an equally scant effort upon their investigation and development. The lack of investigation is indicated by the fact that there has been less than 50,000 feet of diamond drilling done on Ontario deposits, while over eleven million feet of drilling has been done in the adjoining State of Minnesota.

We have many iron ranges in Ontario and some exploratory work has been done on them without disclosing large bodies of ore of the same grade as that which is imported from the United States, free of duty and at cheap water rates. Mr. Flaherty is of the opinion, however, that some of the deposits already discovered could be worked profitably in the face of this competition. There are apparently many who have accepted the view that we know enough about our iron ore deposits to conclude that they cannot be counted upon to supply our iron. So long as this view is generally held there will be little investigation of the facts and we will have continued repetition of pessimistic views from men who have slight knowledge of the facts. The statements made by Mr. Flaherty should help to bring about more activity in exploration of iron ore deposits.

It is well known that the search for iron ore in Ontario has resulted in discovery of very large quantities of material that has an average iron content somewhat below merchantable grade. It is also well known that some attempts have been made to establish an iron mining industry and that these attempts have not been successful. It is, however, unsafe to conclude that none of our known iron ore deposits can be profitably worked or that we have found our best ones. We need more exploration and more effort in devising methods suitable to our conditions.

Those who are satisfied that our iron deposits cannot be profitably used will never determine whether or not this is a fact. The pioneers in this as in other industries will be found among those who attack the problem and keep at it until it is no longer a problem. Exploration of known deposits, search for other deposits, investigation and improvement of processes for treating the ores, may result in the establishment of an iron mining industry here. The optimistic views of Mr. Flaherty are refreshing and, in view of his knowledge of the subject, should have a good influence on the unduly pessimistic.

MINERS AND MINISTERS.

Surely it is misguided leadership that has put into the mouths of honest Canadian miners the vituperative piffle of the following resolution. Unless the Harbour

Local of the United Mine Workers at Glace Bay belies itself in this outburst, the once-canny Scots of Cape Breton have entertained an emissary, either on foot or by post, from Moscow.

"Whereas Bolshevism is the effect only of oppression and tyranny on the part of those in control, as Bolshevism finds no soil to grow in a community of working people who have employment at an edequate wage; and

"Whereas the British Empire Steel corporation and its servants, the Hon. W. L. Mackenzie King, Hon. James Murdock, Minister of Labor, and U. E. Gillen, are appressing the mining population beyond the endurance of men to bear;

"The Harbor Local, 4523, hereby declares that if Bolshevism spreads and gets a firm hold in the mining regions of Nova Scotia, the blame can be directly placed upon Hon. W. L. Mackenzie King, Premier of Canada, and upon the Minister of Labor, Hon. James Murdock, because of their hostility to the welfare of the people of Canada in their servile obedience to frenzied financiers of the British Empire Steel Corporation."

The case of these coal miners, as with others of our industrial workers, seems to be that they are suffering from a bad attack of that common malady, poor leadership. It cannot be that intelligent men really believe what is stated in the resolution; the leaders who proposed it must either believe that this crude means is justified by an unselfish end (wherein they prove themselves ignorant), or else they are pursuing selfish ends (wherein they prove themselves rogues.)

IRON AND NATIONAL MORTGAGES.

The monthly statement from Ottawa of national revenue and expenditure shows a total debt on January 31st of 2,372 millions, which is an increase of 5½ millions during the month, and of 70 millions during the past year. This is a debt of \$260.00 per capita of our population, carrying an annual interest charge of \$13. For the householder, this means an annual payment of \$50.00, on \$1,000.00 borrowed by Ottawa. It represents a mortgage of that dimension on his share of the national assets, and is distinct from the mortgages he has given, and on which he pays interest, to holders of provincial and municipal bonds, to say nothing of such personal matters as houses and automobiles. Now, this may seem rather a burden for the average citizen; yet he is quite able to bear it at its present dimensions.

The disturbing feature is the annual and monthly increase in the mortgages given at Ottawa in our names. Our indebtedness is increasing more rapidly than our population. The vague and vain hopes of the taxpayer for a reduction of his burden seem to coincide with the periodical and perfidious proclamations from Ottawa that we have at last got a surplus of revenue.

Where does all this apply to our iron and steel industry? We can draw more than one conclusion. In the first place, it is to a considerable extent our importations of iron ore, coal and steel products that conduce to the increase of the mortgages we are signing annually; and this is apart from any adverse rate of exchange. The sums we are spending on research with a view to using our own ores and fuels, and making our own steel, in place of importing them, are absolutely piffling compared with the price we are paying, month by month and year by year, for the doubtful privilege of importing. It is easier to sign a mortgage than to conduct a research; but this must not blind us to the folly of piling up debts that may be avoided. The plain fact is that up to the present we have been "penny wise and pound foolish" as regards research. It behoves us to alter our point of view and our habits before we become bankrupt.

A second point, and it is rather a sore point, touches our National railways. The annual deficit on these is roughly equal to our annual increase in indebtedness; but we must not rashly conclude from this coincidence that the railways are the only cause of indebtedness. We want to make our National railways pay. Settlement of the vacant spaces will provide for this eventually, but that will take a long, long time. We have another resource that can be made to produce revenues much more rapidly.

We state often, more in faith than with definite knowledge, that there is enough mineral land traversed by the National railways to provide sufficient freight to make them solvent, if we develop it. This is a fact that we will try to demonstrate more fully in future issues of Iron and Steel. In the meantime it may be stated, without proof, that the major part of our known iron ranges are served by the National systems. If we can make use of these iron ranges, we will have solved, in large part, our railway problem. This brings us back directly to the question of research. What fraction of the annual railway deficit of sixty-odd millions are we spending to try to prevent or reduce its yearly recurrence? What fraction of that huge sum would it take to provide a solution of our difficulty? The first question we might answer definitely, and the sum would seem absurdly small. The second question cannot be answered directly, but the sum will be an insignificant part of sixty millions annually.

Research, and more research, backed by a sympathetic and discerning public, is the answer to the challenge of our increasing national debt.

DIRECT STEEL AND PEAT FUEL.

In many issues, Iron and Steel has discussed the direct process for making steel. As it is of such great potential value to Canada, as a possible means of establishing an indigenous steel industry, it warrants our close and constant attention. Mr. Bourcoud's paper, printed in part in this issue, is unique in that it presents plainly and clearly the elements of the problem—a necessary, but oft-neglected preliminary for all but the few that

have studied the problem at first hand. This much is common ground to all researchers at work on the problem; and those others who wish to consider the problem intelligently should take pains to assimulate the information on the general principles involved, which Mr. Bourcoud reduces to such simple terms.

After analysing the reactions of the blast-furnace and resolving them into their three stages, Mr. Bourcoud discusses the possibility of performing these operations more effectively by other means. The pre-heating of the charge is effected in the blast-furnace in a reducing atmosphere; this could be bettered if oxidising gases were used, particularly to avoid the reduction of noxious elements. The reducing zone of the blast-furnace has never yet been seriously challenged for its efficiency; yet it is quite possible that a reduction by means of proper gases, independent of solid fuel, would give better results. The difficulties encountered by the reducing gases in attacking a lump of ore are clearly visualized; if the lumps could be made smaller than is at present possible, these difficulties would be correspondingly essened.

The meltnig operation at and above the blast-furnace hearth is open to criticism, as it is here that the excess carbon of pig-iron, as well as the other impurities reduced by means of an over-abundant coke, are acquired. An air-tight electric melting-furnace, with no excess carbon present, provides the ideal apparatus for the operation.

Of especial interest to metallurgists in coal-less Central Canada is Mr. Bourcoud's proposal that peat, among other low-grade fuels, should be used in powdered form to make reducing gases in specially-constructed gas-producers. In such a case, the twenty-five per cent. or so of water contained in air-dried peat might prove an asset instead of a detriment, as steam is now commonly used in gas producers to increase the calorific value (and possibly the value as reducing agent) of the resulting mixture of gases. Some success has already attended attempts to use pulverised peat as fuel, particularly in Sweden; and this doubtless foreshadows further attempts, and more success. At any rate, the use of fuels at present useless for the production of iron and steel — non-coking, sulphur-laden and bony coal, and lignite—will augment very considerably the fuel already available for the purpose. Periodically, attention is drawn by the cautions or the conservative, to the comparative slimness of our resources of metallurgical coal, both in the East and in the West, and its high cost of production. If the non-coking coals of Nova Scotia, Alberta and British Columbia and the lignites of the prairies were added, the amount of fuel available might be sufficient inducement to risk the use of our own iron ores.

Thus Mr. Bourcoud demonstrates piece-meal the means of improving upon the present method of making steel. He frankly admits that this demonstration is not sufficient, and that patient, long-continued research and trial must precede a solution of the problem.

May the gods supply in full measure the hope that inspires researchers, lest the rest of us, following the trail blazed (and too often cleared and levelled) by these pioneers, become rooted in our tracks, and finally buried there, to provide fossilized remains for the discovery and amusement of some future generation more discerning than our own.

APPRENTICE TRAINING.

Canada is young. Youth has its indiscretions, among them the supposed privilege of being "sloppy". During the war-time, when Canadians were so thoroughly intermingled with Britishers in the old land and at the front, and close acquaintanceships became inevitable, "sloppy Canadian" became a frequently-used term. We deserve it. We work quickly, whereby a good deal of our effectiveness; but it is undeniable that we have careless habits that prohibit fine or thorough workmanship.

It is well-known that the finest automobiles used in this country come from the other side of the Atlantic. It is likewise becoming apparent, by the shipment of "Fords" and other machine-made cars in the opposite direction, that on this side of the water we excel in so-called "mass-production". Evidently there is room for a trans-Atlantic exchange of ideas.

We shall deal here with our deficiency; it is not becoming to boast.

Mr. Vickers' plea, reproduced in this issue, for a thorough industrial training of workers in the Old Country applies with added weight to Canadians. We, who have got along fairly well with the organization of our social structure in this new land, have barely begun to think of thorough workmanship. Our fathers, or grand-fathers, had to be men-of-all-work, with the axe and the plow as their chief instruments in persuading Nature to yield them a livelihood. We, though a little removed from the necessities of pioneering, still retain some of its ideals and ideas, some of which are not suitable to our present social structure. Chief among the inherited ideas that can serve us well no longer, is that of the Jack-of-all-trades. We no longer have to build each his own house, or make his our furniture; homespun is now a rarity; even the grist-mill has passed. We must now become each a master in some one trade. For the majority of our population, this simply implies thorough workmanship.

In our January issue there was discussed the feasibility and the advisability of organizing an association of the numerous members of our iron and steel trade for mutual help and self-advancement, as well as for the national good. One of the first and fundamental questions to be considered by such an association is the training of workers in the industry. Our present training establishments and devices tend to train work-

ers *out of* the industry, not *in* the industry; that is, workers are trained mainly for "white-collar jobs", and are thereby lost from the ranks of direct producers. What we need is the modern representative of the old apprenticeship system whereby the youth may be trained to become a good journeyman, and the mature worker assured, by his skill, of a good position and fair remuneration. Thus thorough workmanship will come in, and Bolshevism will go out, and "Canadian workmanship" will become a word of praise instead of a term of derision.

EDITORIAL NOTES.

Ventilation of Mines.

The use of compressed air blowers as an aid to ventilation in mines was recently made the subject of investigation by the U. S. Bureau of Mines. The results of study indicate that the blowers are far less efficient than small fans. The investigators found that by use of small unit fans and galvanized iron pipe a supply of fresh air to mine openings is obtainable at about one-hundredth the cost of that obtained by the use of compressed air blowers. In many cases the more costly method gives practically negligible results compared with that of the fan method.

The use of blowers is sometimes justified as a temporary expedient; but publication of this report should make installation of permanent ventilation systems in mines a matter that will receive earlier attention than it does in many cases.

Mine Telephones and Gas Explosions.

That telephones used in coal mines may be the cause of mine explosions is shown by investigations carried out by the U. S. Bureau of Mines at the experiment station at Pittsburgh. The ringing of the magneto makes the telephone in gaseous atmosphere a source of danger. In the trials numerous ignitions and explosions were obtained in a gallery in which there was a mixture of natural gas and air.

The results of the investigation should lead to more care in the use of telephones in coal mines. A type of instrument that lessens the danger should be used. The ordinary mine telephone is not explosion-proof.

A Generous Geologist.

In a recent issue of "Science" there is a description of the gift made by Dr. I. C. White, since 1897 State Geologist of West Virginia and distinguished for his contributions to the geology of coal and petroleum, and Mrs. White to the University of West Virginia and the City of Morgantown. The gift consists of 1,911 acres of coal land in Marion county, and officers of the Geological Survey estimate that the tonnage of the acreage will approximate 15,000,000 and on a conservative royalty basis should yield at least $4,000,000 over a period of years, $2,000,000 to the city and $2,000,000 to the university.

By the deed of gift the university funds are to be used to equip and maintain a geological department at the State university. The city's share is to be employed for the purchase, improvement and maintenance of a public park and for securing, equipping and maintaining a public hospital.

Dr. White, the generous donor, is well known to most Canadian geologists. He is sometimes called the father of the anticlinal hypothesis, which has been of such great service in the development of petroleum and natural gas fields. A year ago, at the meeting of the Geological Society of America in Chicago, he was the retiring president. Dr. White's career illustrates the fact that a study of pure science sometimes leads to great economic results.

MANCHURIAN STEEL WORKS.

Although the report of the American mining engineers who recently inspected the Manchurian coal and iron fields has not been made public, it is learned (by the Far Eastern Review) that, as a result of their investigation, the South Manchurian Railway Company will proceed with their original plan of erecting the largest steel works in the Orient. The scheme as reported contemplates a consolidation of the Anshan Iron Mines and Steel Works operated by the South Manchuria Railway Company with the Penchihu Colliery and Steel Works, a Chino-Japanese enterprise controlled by the Okura interests of Japan. The low-grade iron deposits in Manchuria, which have resisted profitable working under existing methods, are expected to yield profitable returns by the introduction of a new American process plant. When the party of American metallurgists passed through Seattle on their way out to examine the Manchurian deposits, the statement was made by an official of the South Manchurian Railway, that if their report was favourable, it would mean the expenditure of over 110,000,000 dols. in plant and machinery, the bulk of which should be shipped through the port of Seattle. The expenditure of such a huge sum in Manchuria to place in execution the plans for the new industry will have a far-reaching effect on engineering trade in the Orient, as it is expected that the new plant will be able to furnish all the steel products required for the extensions of the South Manchuria Railway system, the Chinese Eastern and Siberian railways, as well as other enterprises in China proper. The proposed plant will surpass the present Japanese Government steel works in output and deprive Hanyang of its lead in China. With the proposed Kailin steel works in North China and similar projects for Kowloon and South China, the contest for the supply of steel to Eastern Asiatic markets, must, in time, simmer down to one between British and Japanese interests. What effect all this will have on the prospects of other nations supplying China with her railway material requirements can be best left to the imagination. Japanese enterprise in this connection strengthens the view that unless foreign manufacturers are assured a proportionate share of the orders for materials used in the construction of Chinese railways financed by the consortorium, it may be exceedingly difficult for the latter to function along the lines originally designed for its operation, without creating friction that will seriously impair its usefulness.

Foundry Iron

By ROLAND H. BRIGGS.

Cast iron in the form of pig is the base of all iron and steel productions, including wrought iron, malleable and grey iron castings. Its production has been the subject of much research and has become one of the most important of industries, and various aspects of the problems connected with it are constantly brought before the iron operators by one or other of the scientific institutions most closely connected with this branch of human activity. On the seventeenth of December an important paper was read in England before the Staffordshire Iron and Steel Institute by Mr. F.S. Wilkinson, in which the development of the blast furnace and its effects on the production of pig iron, and the suitability of cast iron for foundry purposes, were dealt with.

Blast furnaces have been at work in the Midlands of England for many centuries. In the year 1619, they were built of masonry, small in size, used coal as fuel, and had an output of perhaps seven tons per week. Previously charcoal had been used. A great step was made about the year 1709 when coal began to be converted into coke for smelting purposes, and another most important landmark was when the system of heating the blast was introduced. Other signs of progress have been the methods devised for utilising the furnace gases and slag, tending to economical productions; increased height and diameter of furnaces; effecient cooling arrangements; mechanical handling of raw materials and furnace products; and similar inventions and improvements in furnace organisation.

In general it is necessary to charge a blast furnace for each ton of pig iron to be produced with two tons of ore, half a ton of flux, and one ton of fuel, even under very favourable conditions, so that with a two-thousand ton plant the raw materials to be charged into the furnace will amount to at least seven thousand tons per week, and may be considerably more.

Electrically driven, mechanically operated charging apparatus has been installed in Britain in many cases, frequently of the skip or bucket type. In one plant a skip is used with a capacity of 105 cubic feet, with a hoist capable of taking 6½ tons weight, the complete cycle of operations, including loading, travelling to the furnace top, discharging and travelling back to the bins, taking only 100 seconds. The pig iron after production is handled in modern plants by a number of machines, including cranes, electro-magnets, and pig breaking machines. Pig casting machines, with capacities up to 1000 tons per 24 hours, are also used.

Equipment for the cleaning and scrubbing of blast furnace gases is used at modern plants to eliminate dust from the gases. By the efficient use of the various systems which have been evolved for this purpose, the dust content of the gas may be brought as low as .003 gramme per cubic metre, the efficiency of the gas in the stoves being raised as much as from 20 per cent to 30 per cent. as a result. Potash and other valuable bye-products are now recovered from the gas.

While great progress has been made with regard to the quantity of pig iron produced, the quality, in the opinion of Mr. Wilkinson, has deteriorated. In furnaces worked with cold blast at low pressure, the reduction of the iron from its ore was carried on slowly, the materials charged into the furnace were of selected quality, and the iron produced of high class. The slower the rate at which the furnaces is worked, the better is the product obtained. Small furnaces with the same blowing period as the larger quick-running furnaces make a product that appears to have superior properties although of the same chemical analysis as the rapidly produced iron.

The old method of selecting iron for foundry use by fracture has largely been replaced by the system of scientific analysis. Carbon must be considered as existing in the iron in two forms, graphitic and combined. Molten iron contains carbon in its combined condition, and the rate of cooling and percentages of other elements present will determine whether the carbon separates out as a graphite or remains in the combined condition.

Most pig iron contains from 3 per cent to 4 per cent carbon, and the lower the total carbon, the stronger the casting will be, providing the graphitic and the combined are in the proper proportions. Graphitic carbon causes the iron to have an open grain, and if the crystal is large, planes of weakness are formed. The smaller the crystals, the tougher the iron will be, if the silicon content is also right.

The combined carbon gives to the iron its hardness, density, strength and chilling property. It closes the grain, but is an element that will give the founder much trouble if in excess.

Silicon has a great influence on the condition of the cast iron but promotes soundness and fluidity, and carbon, tending to separate it as graphite. It weakens acts as a softener and prevents chill. If the silicon content is more than 4 per cent, the power of the iron to absorb carbon during reduction in the blast furnaces is lessened, and the higher the percentage of silicon, the lower the total carbon will be.

Sulphur has an opposite effect from that of silicon. It tends to prevent the separation of the carbon as graphite, making the metal harder and increasing the shrinkage. In limited amount it strengthens cast iron, and its bad qualities are considerably reduced in the presence of manganese. Its tendency to retain the carbon in the combined condition gives it a chilling power, and the percentage in strong castings may be as high as 0.12 per cent, without seriously affecting the strength, while improving the wearing qualities. It is, on the other hand, in the case of machined castings, a fruitful cause of hard metal and blowholes, if in too high a percentage. It usually increases as the silicon content decreases.

Phosphorus in iron is of great importance; it promotes fluidity and helps the running of thin castings, but over 1.5 per cent makes the iron very hard and brittle. Practically all the phosphorus in the ore from which the pig iron is made will enter the iron. The phosphorus percentage should be kept very low in castings designed for high temperatures.

Manganese has a great affinity for carbon, and its presence tends to harden the iron, and increases the shrinkage and chilling properties. The manganese is present in two forms, manganese sulphide or iron-manganese carbide. The former is less harmful than the latter. In re-melting the iron through the cupola, there is usually a decrease in the amount of silicon and manganese, due to oxidation, and an increase in sulphur, drawn from the coke. The phosphorus may be increased, but the total carbon will not be much altered.

Pig iron that will give a hard regular chill whe

cast against an iron mould is required for many purposes, such as rolls, car wheels, brake blocks and stone crushers. The proper control of the silicon and carbon in the iron seems to produce the best results with regard to regularity of depth of chill, hardness and wearing properties. Sulphur and manganese both tend to the production of a deep chill, but castings with these elements in excess will not be so satisfactory as those in which the chill has been obtained from the silicon and combined carbon.

A good chill should show a gradual change in the appearance from white to grey, with intermediate mottled. The use of pig iron smelted direct from ironstone through the blast furnace will give better results than a refined iron in which the silicon and carbon have been artificially affected by the introduction of steel scrap or other material. The temperature at which the iron is cast and the thickness of the iron mould must be taken into consideration. If the iron is poured at a high temperature the depth of chill will be greater than if the temperature is lower.

IRON AND STEEL TRADE IN GREAT BRITAIN.

The following statement, exclusive to "Iron and Steel" from H. M. Trade Commissioner at Toronto, gives the latest official summary of conditions in Britain.

Although the actual amount of business being done in the iron and steel trades continues on a small scale enquiry is broadening, and the opinion is fairly general that the New Year will witness improved conditions.

Prices have been brought down to a level which consumers are beginning to regard as being very near to bed rock and a more confident feeling is gradually asserting itself.

As confidence in the market strengthens, it is hoped that consumers will depart from the policy they have pursued for so long of merely covering themselves tor their immediate requirements, as producers are greatly handicapped in their operations when business is confined to orders for small quantities of material.

No great improvement in the Cleveland pig iron trade is observable at present, but the outlook is a little brighter than it has been for some time. The Cleveland makers have experienced very severe competition from the Continent during the past few months, with a view to meeting which they have made several reductions in prices, the most recent one of 10s. per ton having been announced early in December. It is hoped that this latest cut will stimulate buying and so provide some encouragement to makers to increase their output.

The position of steel works has become rather better as a result of the weakening of foreign competition, but the amount of business passing is still small and many of the works are greatly in need of orders.

The railways companies have been urged for some considerable time by the iron and steel industry to lower their transport charges in order to assist in bringing down production costs and sellng prices of British material, and it is satisfactory to record that it has now been announced that the English and Welsh railway transport charges on coal, coke, patent fuel, lime and certain classes of iron and steel material, are to be reduced from the 100 per cent. increase over pre-war rates which has operated since September, 1920, to 75 per cent increase, the new rates to take effect on and after 1st January.

This decision of the railway companies should greatly strengthen the confidence of buyers. While the question was pending the cautious attitude adopted by consumers was perhaps only natural, but this further step in the direction of stabilised conditions will no doubt do much to improve matters.

The National Federation of Iron and Steel Manufacturers provide the following statement regarding production during December:—

The production of pig iron in December amounted to 275,000 tons, a figure slightly in excess of the production in November, when it was 271,800 tons. The furnaces in blast at the end of December numbered 77 compared with 85 at the end of November, 15 furnaces having gone out of blast during the month and seven re-lit. The production of pig iron for the year amounted to 2,611,400 tons compared with 8,007,-900 tons in 1920. This figure is lower than in any year since 1850 when the production of pig iron amounted to 2,249,000 tons. Of the production of pig iron in December 92,400 tons were hematite, 81,500 tons basic, 13,800 tons were forge, and 78,600 tons were foundry.

The production of steel ingots and castings in December amounted to 381,000 tons, or 62,000 less than November. The total production of steel for the year amounted to 3,624,800 tons compared with 9,056,800 in 1920. The following table shows the production of pig iron and steel for each month in 1920 and 1921:—

	Pig Iron.		Steel Ingots and Castings.	
	1920. Tons.	1921. Tons.	1920. Tons.	1921. Tons.
January	665,000	642,100	754,000	493,400
February	645,000	463,600	798,000	583,500
March	699,000	386,000	840,000	359,100
April	671,000	60,300	794,000	70,600
May	738,000	13,600	846,000	5,700
June	726,000	800	845,000	2,700
July	750,600	10,200	789,900	117,200
August	752,400	94,200	709,200	434,100
September	741,000	158,300	884,700	429,300
October	533,200	235,500	544,300	405,400
November	403,200	271,800	505,100	442,800
December	682,500	275,000	746,600	381,000
Total	8,007,900	2,611,400	9,056,800	3,624,800

STEEL MACHINERY SECRETLY MADE IN U.K.

New York. — Sheffield, England, newspapers state that 200 tons of machinery manufactured secretly left Sheffield, Friday, for the Basset Works at Domicile, France. The machinery is apparently to be used for the manufacture of steel direct from ore, the papers said. The discovery of the Bassett process, eliminating blast furnaces, was announced last May. The process, it is claimed, means important economies in steel manufacture.

Bradley Stoughton, formerly Secretary of the American Institute of Mining and Metallurgical Engineers, was elected President of the Yale Engineering Association at the Annual Meeting on February 2, 1922.

Industrial Training for Foundry Workers

By Thos. Vickers, C. E. Secretary of the British Cast Iron Research Association.

The following article, from The Foundry Trade Journal of January 19th and 26th, gives in brief form such an interesting account of the history of casting metals that it is worth the attention of that trade. Its main theme, industrial training, has received scant attention in Canada, and must be studied if we are to progress with the times. We commend the article, even in its present abbreviated form, to our readers.—Ed.

During the past few years greater attention has been paid to the question of foundry training than in any previous period, and whilst there has been much talk there does not appear to have been much advancement beyond the conditions that existed say 10 or 15 years ago. The subject is, however, of greater importance to-day than it ever was, and affects not only the economic position of the worker but the very existence and character of the industry as a whole.

Industrial training for the worker is no innovation of the 19th or 20th Century. It is but necessary to read the fascinating history of the ancient founders to find how, although their early efforts were crude when compared with their later work, they developed in time a system of art and science all their own, which in conception and execution stands unsurpassed among the creations of any modern nation.

Historical Notes.

The discoveries that have recently been made in Greece convince us that the Egyptians, 6,000 years B. C., had reached a very high degree of mechanical precision, and worked with tools that were marvels of ingenuity and accuracy.

The metal artificers of King Solomon's time must have been possessed of wonderful skill in the casting of metals, judging from the massive bronze castings that were made for the Temple 1005 B. C.

There is no doubt that Tubal Cain was both a brazier and a pattern-maker from the results he obtained. Then, curiously, history from 1000 B. C., so far as the foundry is concerned, is found to be a perfect blank. Something then happened, the promised civilisation lapsed and there appears a long period, dark and chaotic, until a time is reached when the Greeks started their Guilds of Training, which resulted in a wonderfully rapid advancement in the arts and crafts, especially in the art of bronze founding. Probably the finest example the world possesses in the moulders' art was made at this period, 300 B. C. A piece of work called "The Bronze Horses" are beautiful castings now adorning the front of St. Mark's Cathedral, Venice, as perfect to-day as when made by the moulder 2200 years ago. And so we could go right through this old history of the trade, and see how the early foundations of the training in foundries were laid down—foundations which were made solid and sure for all time, and from which we are even to-day reaping the benefit. It is then seen how, in the merging of the stone age into that of iron and of bronze, when primitive man began to develop higher grades of implements for warfare and agriculture, the art of the foundry came into existence. For centuries men were limited to the casting of bronze weapons and domestic utensils by pouring the precious and dearly won copper alloys into baked clay and permanent stone moulds (for permanent moulds are 20th century discovery). Cast-iron was but an accident, incidental to the imperfect smelting of iron ores, and considered highly undesirable.

Whilst, therefore, the art of moulding in its crudest form was known in these early days, the real dawn of the foundry, as an industry useful to the world's development, dates only from the middle of the 15th century. By dint of very great and patient work, and the training of the rough workmen by the founder himself, it was then found that the much despised molten product from the furnaces and forges yielding iron could be cast into moulds of clay and sand to make cannon balls and the like.

Even though the art was closely and jealously guarded, the training of apprentices was taken up by the powerful trade guilds of those days, and soon spread knowledge of the art of casting iron far and wide.

Coming to the middle of the 16th century, guild classes of foundry apprentices were then found being held during the winter evenings in the County of Sussex. These were probably the first foundry classes in this country. The foundries were situated in isolated places, and the guild classes were held in buildings whose construction allowed the unobstructed entry of the bitter east winds to sweep right through them. But the foundry worker of this period was determined to learn, he was a man held in very high esteem, he was proud of his work, and he worked hard to progress. There is no doubt that this pride of his craft was the first step in the originating of craft guilds, and from these, without doubt, the later trade unions sprung. The training of these old guild classes was not simply a training for a trade, but training also of character and intelligence to make the boy into an efficient craftsman. What an object lesson it is for the present time!

Worshipful Company of Founders.

In 1590 the ironfounding industry was so powerful and held such a premier position amongst other industries that the Worshipful Company of Founders was formed, and received a coat of arms from the King. The Company's Charter states that they had to supervise "the manufacture of candle-sticks, household utensils, ewers and spurs, **and the training of apprentices.**" An old record of the work of the Company states that it did much good in keeping the craftsmen of that day up to the mark, it maintained the purity of the metals used, and fostered the desire among the workmen to attain the highest possible skill in artistic workmanship. Considerable time could be spent with this fascinating period of old foundry history from 1550, when the first book on iron published in this country was written by Agricola, and the great struggles of these early founders down to 1800 could be usefully studied, when it would be seen how their primitive knowledge and science triumphed over all their difficulties, and it will be found that the incentive in those days was the continual anxiety of the young guild apprentice to learn his trade.

Is the craftsman of to-day as proud of his trade

or occupation as the old artificers? If one could say "yes" to this question, there would not be quite the necessity to discuss so much the subject of industrial training, neither would there be the scarcity of good moulders in the foundries that we find to-day. Is it not worth while to alter such a condition? Engineering mechanics who assist in building a great bridge are proud to discuss such an occupation, although they are but following out the principles and design laid down by the chief engineer and designer, and errors and failures do not effect them. A moulder, however, has to bring to bear the personal human-element and skill, and his work stands out prominently as his own personal achievement, and these achievements are often such that no skilled engineering mechanic could carry out. The most perfect casting in the world is one that it is said a great engineer prophesied could not possibly be carried out, namely, the great bell at Moscow, 19 ft. high and 19 ft. dia., weighing 200 tons, which was cast in 1733, this bell being the work and contrivance of an old working moulder. This fine example of the moulder's art does not stand alone in the proud achievements carried out. Therefore, the first stage in attemping industrial foundry training should be to get the workers to regard their trade as a craft and have pride in belonging to it.

The industry has made many strides since the first moulding machine was patented in 1869, followed by the first jolt machine in 1878, especially in organization and quantity production, and while many of the foundry operations of to-day are similar to those carried out in the 17th century it has to be admitted that it would tax our present skill and resources to duplicate some of the productions of the ancient foundry . For the moulders then reached a very high state of excellence, in fact it can safely be said that the work produced between the years 1510 and 1670 has never since been surpassed or even equalled by the present-day muolder. An examination of the beautiful cast-iron monumental slabs scattered about the churches in Sussex, and the cast-iron grate backs with their wonderful ornamental work are all worthy of examination by would-be moulders.

Modern Requirements.

The rule of thumb methods, the secret and mysterious processes, so jealously guarded by our industry, are gradually disappearing. Through the efforts of the Institution of British Foundrymen and technical literature, the results attained by progressive foundrymen are now placed at the disposal of all who wish to avail themselves of the knowledge. In the foundry business, as in any other, there is no royal road to success,and while the young man may be willing to work and study he is at present handicapped by a naturally limited viewpoint. The men in charge of foundries, with their wider experience, should consider it as much their duty to encourage mental development of the younger men in their charge as it is to develop their own skill. Industrial training does not only apply to the foundry apprentice, but it is very necessary for all grades of the organization, which really means the improvement of the human element in our foundries. There is, without doubt, a definite need for better educated men on the productive side of our foundries: this is being keenly appreciated in America. The term "educated" does not imply a higher-grade or grammar-school man, but that education which gives a breadth of view and which develops an appreciation of the human aspect no less acute than that relating to the inanimate features of the foundry. The greatest asset of such a man is the capacity to impart knowledge and method as to why and wherefore things are done, to those around or under him. But this teaching is a thing which one rarely finds in any works. It is the improvement of the human element that will have to be brought about in the foundry industry, for it is possible that it has been given its true value when measured by the cost of the finished casting. This is especially liable to be the case in iron foundry work where the operations are so varied that it might have been considered that the ordinary foundry worker could not possibly feel interest in the processes involved, viewed as a whole. It is, however certain that men cannot intelligently avoid making poor product if they do not know what constitutes poor product, which condition exists in our foundries more than is generally supposed.

Conditions in Foundries.

There is no doubt great room for improvement in the condition of some of our foundries, yet if compared with the conditions that existed 20 or 30 years ago wonderful progress has been made, and many foundries to-day are really fit to house human beings during working hours. Foundry work itself has made rapid strides in improvement. Transportation of material the melting processes, the handling of the cast product, all have improved, and much of the hard labour of the moulder has been shouldered by the moulding machine. But in spite of all this it has to be admitted that in the actual distribution among the workmen of the fundamental knowledge of the founder's art and in the training of the foundry youth no advance has been made.

The work of helping the foundry workman to enable him to give greater returns of good castings, not by mere physical effort but by the application of a better trained intelligence, cannot be started too early. Youths must be attracted to the foundry, so that the supply of skilled moulders may be kept and increased.

The author was recently asked by an employer if he really thought there was any profit in endeavouring to educate the employé. Undoubtedly, the education of the employés is one of the most powerful single influences which can be brought to bear in the greater development to the industry. Everybody should realise that a man must know in order to do. The workman must have knowledge of his work in order to give the best service. Many large works in this country, and more especially in America and Germany realise this by the introduction of works classes and works schools. These introductions are productive and wise, especially where is found that an important part of the educational progamme is the study of the fundamentals of the industry itself.

The Effort of the B. C. I. R. A.

The British Cast Iron Research Association is now at work in an attempt to improve and modernise the methods of foundry production, and the results of the operations of the Association have already made important changes in the ironfounding industry, and the changes will grow more and more as the work proceeds. What does this convey? Is it possible to obtain the best practical results from that Association's work unless the foundry employé is able to carry out such improvements? As the methods of production alter or are improved, it will become more necessary for foundries to employ trained and better skilled men than they are employing at present. Is

such a course economically sound? One has but to look at the enormous strides made during the past ten years in the American foundries, by their industrial training system.

Germany entered the contest for industrial wealth late in the day and with many disadvantages, but she has made the most skilful and vigorous use of the complete realisation of the fact that "knowledge is power". The industrial progress of Germany between 1870 and 1914 is amazing to anyone who does not realise the potency of industrial training of the worker which she used to secure her position. Germany has for the last 20 years paid particular attention to the training of her apprentices.

The Dearth of Foundry Classes.

The B. C. I. R. A. has fully realised the necessity of practical training for the foundry employé. It has formed an influential Educational Committee, which has approached the whole of the Technical Institutions in Great Britain with a view to obtaining their co-operation. It has been found that in the whole of the country there are only 21 technical school classes for foundry employés—a most astonishing position. The Association is preparing a suggested syllabus of practical foundry instruction, and will obtain the support of all the various technical schools for its adoption. The Association has obtained powers to offer bursaries and scholarships to foundry apprentices, and these in time will be put into force. As far as the Association can assist, everything will be done to further the training of the apprentice moulder, because upon him will depend the carrying out the future practical work of the Association.

A Technical School Failing.

Destructive criticism of technical educational system is one of the commonplaces of the present time. But it should be remembered that education has two functions. On the one hand, it has to furnish the student with information, and seeing that the extent of information which the student has acquired can be tested more readily and more certainly than other qualities, this function of education is too often taken to be the whole or the most important part of it. As a fact, however, the information a boy gets during his school days is probably the least important result of his education. The school's business is much more to teach a boy how knowledge should be acquired, than actually to make him acquire it.

When this is borne in mind, it will be seen that the most important things technical education can do for a boy is to give him practice in observing the materials with which he has work, in making a job of whatever he does, and in facing and overcoming difficulties for himself, and if technical schools adopted this principle a different class would be found even in foundries. Great importance should be attached to the technical school foundry classes as being the foundation upon which we can build any sound scheme for the future improvement of foundry labour.

Meeting Foreign Competition.

There is not the least doubt that competition in the future is going to be keener than ever experienced by the oldest foundry. Foreign competition has now to be faced by the most modern foundry plant and equipment, and it requires all the help possible from the technical schools to assist in meeting it.

The training of the employee does not mean only apprentice training, but the training of the foreman and the executive as a whole. Some guiding rules can be laid down for the consideration of that industry. Men should be taught:—

Firstly.— Why it is not fair to do less than their best. This implies knowledge on the part of the men of possible losses to be sustained through poor workmanship.

Secondly. How they can give full value with the least expenditure of effort on their part. This implies knowledge on the part of the men of methods and reasons.

Thirdly.—They should be taught wherein lie the interesting points of the work they are doing. This implies knowledge on the part of the men of processes beyond those with which they are immediately dealing.

And, fourthly.—Every workman should know or be told what he is doing.

What does this last apparently simple item mean?

Interesting the Workman.

As a rule, the ordinary workman knows very little about the inside working of the shop in which he works, and very little, if anything, about any other shop. As a natural result, continuity of operation is secured principally through blind obedience to orders, and not to any intelligent conception of the effect of one shop's work upon that of another shop, nor has he a clear understanding as to what the works manager is really trying to accomplish. It is a true axiom that no job was ever done less efficiently because all the men who worked upon it knew the reason for what they were doing. Men should be taught to see the end of the process as well as the beginning. Each man should be taught to realise his own personal responsibility in connection with the condition of the finished product.

The American Ideal.

In America the idea upon which the plan of teaching is based lays stress not so much upon the development of manual skill in the moulding operations, nor primarily upon a knowledge of the practical details involved in the mechanical production of moulds, but rather upon the development in the perspective by the student and of an appreciation of the broad executive and administrative problems involved in the commercial conduct of a foundry. With this thought in mind, attention is given to organisation, scientific planning of production and accurate time study. The laboratory courses approach as much as possible commercial realities.

It is often said: "It takes time to train green boys, and as soon as one has been trained he leaves." However, a systematic plan of apprenticeship entered into seriously with terms just to both the employer and the boy and with sufficient guidance from the foundry manager, will bring results that will outweigh all objection, and, as a consequence, the whole industry will profit.

But is it a disadvantage to have good men go out to other foundries after completing their apprenticeship? It is really the best experience a man can have. By going into different shops his knowledge and his outlook are widened, and possibly he will return later to his first shop to become a valued worker.

If foundry managers give more attention to the boys under them, get acquainted with them, make their work interesting, put the stamp of their own personality upon them, and impress upon them that future skilled workers are selected from them, they will put better efforts forward to secure such positions.

One of the supposedly important features of progress during the past 25 years in the foundry is known as specialisation, but specialisation, like many other seemingly good things, has its limitations and its great drawbacks, chiefly monotony, and it is at last beginning to be realised that specialists are not thorough as mechanics, and it is very detrimental to the employment of apprentices.

The industry is therefore faced with a problem of the utmost importance. It does not matter whether the present condition of lack of apprentices has been brought upon us by the desire of the employer for increased production or decreased cost, or both. But unless the foundry is made more attractive to young men and an efficient system of training is adopted, there will be very few capable all-round moulders in the next generation.

Continental Apprenticeship.

A visit to some of the Continental foundries will bring home the difference between our system and theirs. Both in Belgium and France the boys are separate from the men, they are educated during working hours, every boy's record is known and recorded, he is taught not only how to do things but also why it is best done in that particular way. The personal influence of the teaching and training of the older skilled man is such that it leaves an impression upon the lad's career. A Belgian manager has said that his boys were the best paying part of his foundry; he obtained from them not only good work but good workmen.

The Institution of Engineers (Scotland) have just issued an exhaustive report upon Apprentice Training, and recommend that the sandwich system is the best course to adopt.

"The Committee think that the 'Sandwich System,' under which apprentices spend part time in the workshop and part at school, should be encouraged in the case of apprentices. Those who train on this system should spend at least three and a half years in the workshop. The Committee strongly recommend the advantage of this system of combined theoretical and practical training as providing a young man with the best means of preparing himself for higher work in the engineering industry."

A German Scheme.

Possibly one of the best schemes for apprentice training is that of Ludwig, Loewe & Company. Extracts from their scheme are as follows:—

Apprenticeship extends over a period of four years, and takes in the following practical work:—

Moulders.—Sand cores, nine months. Loam cores, six months. Sand moulding, twelve months. Carpentry, three months. Large sand moulding, seventeen months. Testing and trimming, one month.

Loam Moulders.—Loam cores, six months. Carpentry, two months. Small loam moulding, twelve months. Large loam moulding, twenty-seven months. Testing and trimming, one month.

School Work.—Two afternoons a week one from two to six and the other from four to six, extending over the whole period of four years.

First Year.—General intelligence, two hours.

Second Year. Workshop, two hours.

Third Year.—Raw materials, two hours.

Fourth Year.—Foundry education.

This syllabus indicates that, while a considerable part of the time is occupied with work directly connected with the practical side of the foundry, the most important side of the education is the development of the true idea of citizenship and general intelligence.

THE IRON INDUSTRY.

By J. J. O'Connor

There are few, if any, more practical contributions toward the solution of that seemingly age-old problem, of how to establish an independent, self-reliant iron industry in Canada, than that offered by Mr. W. M. Goodwin, in a recent issue of the Journal. The key note is co-operation of practical business men with the highest scientific knowledge obtainable, in order that methods may be evolved, and means provided for the utilization of our own ores, as a basis for the industry.

Mr. Goodwin's suggestion, that an iron trade association be formed, is both feasible and praticable, and could be brought about at comparatively small expense. No great trade enterprise of to-day is conducted without such an organization, in full co-operation with the best that science offers, in every detail pertaining to the operations.

That the manufacture of iron and steel is worthy of such an organization, is beyond question. The many ramifications of the industry multiply the necessity for such assistance, in trade, legislation, sources of raw material, the application of science, and greater, than all, the present condition of the industry in Canada.

The precedents for such action are limited only by the number of manufacturing interests in this and other countries, where the fullest advantage is taken of all that science and practical business methods is capable of accomplishing.

If permissible, advantage should be taken of the meeting of the Canadian Institute of Mining and Metallurgy, at Ottawa, in March next for the furtherance of the timely suggestion of Mr. Goodwin. A representation of the men interested in metal mining and metallurgy would be present there, in greater numbers than would be likely to attend a conference called for this especial purpose. Both the time and the place would be opportune. Cabinet Ministers and Members of Parliament could attend, and learn much of the requirements necessary to place Canada in an independent industrial position, and the possibility of promoting the iron and steel industry through legislative channels.

BRITISH COAL TRADE.

We heard a great deal in a pessimistic vein about British coal before and during the strike of last summer. At present, with the miners hard at work once more and trade conditions improving steadily, the reticent Britisher has become clam-like again; but occasionally an optimist holds forth.

E. T. G. in the "Birmingham Mail" says the potential markets for British coal are vast. It is officially calculated that France will need to import 20,000,000 tons a year for several years. Italy will need at least 10,000,000 tons a year more than she can produce. Scandinavia has been in sore straits for coal ever since 1914. In Spain it is admitted by the Marine Minister that 135 tons of British coal will do as much work as 280 tons of Spanish coal. From the Pacific Coast of North America it is declared that our coal is 20 per cent. better than any other coal landed there. In Chile, Brazil, and the other South American Republics there is pronounced preference for British coal, and our agents there are now beating United States sellers. A little more patience and hard work and British trade will boom.

The Direct Process*

By A. E. Bourcoud.

Direct process investigations and propositions are generally received by a large majority of iron masters and industrial iron metallurgists with marked indifference and suspicion, considering the issue as being a futile and pedantic attempt to replace and outshine our modern blast furnace—the base of our steel industry—with all its accumulated improvements, large tonnage production, long practice and established traditions. This assertion has to be modified for lack of proper foundation, as it does not represent the real situation in either its true industrial form or its purely scientific aspect.

Cast iron is the principal commercial product of the blast furnace. Taken alone as a process for the direct manufacture of cast iron, it is universally recognized as one of the most perfect metallurgical working agencies in existence. Its present state of development has practically reached its final stage, leaving very little opportunity for further improvement. This is the as-
issue.
pect of the critic of the direct process, but it is not the

The greater and by far the most important industrial use of cast iron is to serve as raw material for conversion into steel, either by the Bessemer, the Open Hearth, or by any other process. With this application, the blast furnace, broadly speaking, becomes in its greater field of action, an adjunct to the steel plant, losing all its individual economical characteristics, becoming a part of a more complex system of manufacture, whose merit has to be judged by the collective work accomplished by the whole group as a single unit, and not by any particular one of its components. This is the true aspect of the question and the real issue.

Marion Howe has said that cast iron is a grade of steel. The trouble is that the blast furnace goes further than necessary, passing during the course of its work through the steel grade of steel without any stop, to arrive finally at the cast iron grade of steel, and the product has to be brought back, with extra fuel, labor, capital investment and the inevitable loss of metal.

To appreciate at first sight to what extent these drawbacks are influential in the industrial results, nothing is better than to suppose, for the moment, that the blast furnace, with the same amount and kind of fuel, labor, material and expenses, were able to produce directly, the steel grade of steel instead of the cast iron grade of steel which it usually produces—the former being a product necessitating, notwithstanding, less reductive work and the same general conditions.

Comparing this direct steel blast furnace with the combination of the cast iron blast furnace and the open hearth, or even the converter, it would be found under ordinary conditions, that per ton of melted final product, the ratio of fuel consumption would be as 100 to 125; the total capital investment as 100 to 175; the cost per ton without profit, but with the usual fixed charges, as 100 to 135; and finally, taking the minimum market value at which the product manufactured by the combination can be sold, the return on the total capital investment would be 42 per cent and 6 per cent per year respectively. It is these comparative industrial aspects that furnish the reasons for the existing incentive for possible improvement.

In comparatively recent years interest in the research on direct production of steel in accordance with modern lines has been revived, and a few eminent metallurgical authorities like the late Prof. Wedding, of Berlin; J. O. Arnold, of Sheffield; A. Stansfield, of Montreal; and J. W. Richards (recently deceased), of Lehigh, Pa., have had the courage of their convictions in maintaining an independent attitude notwithstanding the general indifference, especially of those who should ultimately be the ones directly and materially benefited by any valuable contribution.

To start with, and to be quite fair, it should be mentioned that the blast furnace—of which we are so justly proud—was not invented with the intent of producing cast iron, but rather it is the natural evolution of the old Osmund and Stückofen types of furnaces, which were nothing more than the results of vain attempts during the thirteenth century to industrialize the Catalan Forge, with the main object of producing sponge iron in large quantities, but finding, instead, a new and unexpected form of final product.

When cast iron appeared in the fourteenth century, it was the most undesirable and unwelcome product to the iron makers of the day, as they did not know what to do with the new metal and how to handle it. The changed method was accepted, however — even though it was not all that was desired—as being a more economical solution and providing larger reducing units for treating iron oxides. It, however, created new and important problems to be solved, at the same time giving birth to the real metallurgical inventions which were found necessary to convert the cast iron back to soft iron again, the soft iron being the final product sought.

The finery, the puddling, the converter, the open hearth and all its modifications have followed. Meanwhile the blast furnace firmly established as their raw material purveyor, improved rapidly up to its present state, keeping always within the original and fundamental lines. It is today the solid base of our huge steel manufacture, together with the Bessemer converter and the Siemens-Martin furnace variations.

Three Main Stages.

Reviewing in general the action on the charge through the different working zones of the blast furnace, it can be divided into three main stages (1) pre-heating, preparatory to reducing; (2) reduction by gases, practically completed; (3) preparatory overheating, completion of reduction, and melting, through a very strong reductive fusion. The work is continuous, the stages overlapping each other, with the appearance of a flexible arrangement, but forming in reality a rigid system without elasticity or independence.

Considered from a chemical point of view, the most important and complete of the different stages, is the reduction of the iron oxides by the ascending current of gases; it is perfect in action, constant and reliable; its practical results have never been duplicated in any of the numerous attempts made in the direct methods. It is the fundamental operation of the blast furnace, and its highly efficient work has made good and acceptable the other inconveniences typical of the system.

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* Extracts from a paper presented at November meeting of American Iron & Steel Institute, New York, 1921.

Of the remaining two stages, the first or pre-heating, is not only incomplete, but harmful to certain elements due to its overlapping and reducing influence; the third, or overheating and melting operation as it is carried out, is the main cause of the extreme difference between the two products—cast iron and steel—due to the reduction of undesirable elements by the unavoidable presence and contact of large masses of solid carbon at the critical moment where it is least desired.

We may conclude from this preliminary survey that in order that a direct process may take due advantage of the blast furnace experimental data, all the above mentioned working stages must be planned as independent operations and independently regulated so as to establish a flexible system which will at the same time be more adaptable to varying conditions. The first stage or preparatory heating has to be improved; the second or reduction has to be duplicated, if possible; and the third or melting, radically changed.

Departure from blast furnace lines.

Such an arrangement means a complete departure from blast furnace lines, inasmuch as the two final products demanded are so fundamentally different, although so near in their generic form. This necessity has been recorded by the majority of experimenters.

By adopting a proper pre-heating operation under decided oxidizing influence, we have the necessary improvement of the first stage and by melting with modern agencies under special atmosphere and out of contact with any fuel, we can change radically the third. Then the stages first and third can be satisfactorily arranged in the right direction with only our present knowledge experience and approved working agencies.

With reference now to the second stage, how and with what means it should be possible to effect, under the new conditions, a positive duplication of the practical results of the reduction carried out in the blast furnace, is what in reality constitutes the backbone of any direct steel proposition, as has been recognized by all previous investigators.

It is within this scope that the problem is considered here in this unpretentious essay, and a possible solution suggested with all the appearances of a practical realization, under the economic conditions required to place the process on a favorable competitive basis with our present methods of manufacture.

Solid Carbon versus Gases as an Effective Reducer.

Both methods of carrying out the reduction have their respective partisans, and have been the subject of many controversies in the numerous trials and experiments since the first attempts.

Without discussing and questioning here whatever might be the merits and advantages of the employment of solid carbon intimately mixed with the iron ores, it is a recognized fact that the complete reduction of the ore in the solid state with only the agency of solid carbon in order to obtain a solid deoxidized product, is physically impossible owing to the lack of adequate contact of the reducing agent with the inner part of the grains of ore, no matter what is the degree of fineness of the grinding and the homogeneity of the mixture. The practical results obtained with this method of procedure are, however, due to the beneficial influence or action of the gases evolved in the operation. Were it not for that help, the reduction would be faulty and incomplete. If the gaseous phase takes such an important part in the most critical period of the penetration and completion of the reaction, there is no doubt that the whole operation can be carried out also with gases alone, provided these gaseous reducers are placed in the right and necessary conditions to do thorough work as is the case of the blast furnace.

The present investigation belongs to the class of processes based on the employment of gaseous reducing agents alone, without contact of any kind between solid fuel and the ore charge, either in the reduction or the melting operations.

The Reduction Problem.

Among the principal causes of industrial failure in the solution of the direct process problehm, are two that can be said to form the main obstacles in the practical and economical realization of the scheme, namely:

(1) Deficiency in the methods of generating economically and practically a Reducing Gas, of great purity, and at the convenient temperature, using ordinary and low-grade fuels.

(2) Deficiency in the methods of applying a current of Reducing Gases, to the treatment of the iron ores, in order to obtain a complete reduction, with the minimum volume of gases.

The joint solution of these two points is necessary in order to avoid the economical and technical failures of past attempts, because the same unsatisfactory results would be obtained with a perfect reducing gas and an imperfect application as also with the use of an imperfect reducing gas combined with a perfect application.

It can therefore be said that the necessity of solving both important phases of the operation is a most desirable one, with reference to the generation of the reducing gas, but with regard to the question of its utilization, it is of a vital importance. Indeed, both objectives have to be fulfilled, if a direct process is intended to take industrial rank.

The Reducing Gases.

A reducing gas, for all practical purposes, can be considered unsuitable to do a reductive work, when its degree of saturation, or in other words, when the ratio of the volume of the oxidizing elements contained in the gas, to the volume of the oxidizing *plus* the reducing elements, is equal to a value approaching 0.30; that is to say when a reducing gas emerges from a reducing furnace, after a reductive task, with 70 per cent of its reductive elements intact or still untouched, it is considered in good practice to have accomplished a perfect industrial work as far as possible. Blast furnace top gases very seldom reach these figures, being as an average of a value between 0.25 and 0.28. Cases are cited, in some reports with such a high value as 0.35, but these are far from being the result of daily practice, and are not considered for a single moment here at the present time as a base for further calculations.

It can be easily inferred that in order to have the greater utilization of a given volume of reducing gas, its degree of saturation must approach as near as possible, a value equal to 0.00 when entering the reducing furnace. These conditions, however, cannot be easily fulfilled in a work of everyday routine. The ordinary producer gas, has a degree of saturation already when leaving the producer, between 0.11 and 0.26, in its dry analysis, which always conveys a lower value than the real one, on account of appreciable quantities of undecomposed steam, which passes away with the gases.

Another important phase in reduction with gases is the temperature at which the operation is carried out. At a low temperature, the reductive action of the gases is nil, while it grows as the heat is raised. On the other hand, the same thing occurs with the oxidizing energy of the oxidizing elements contained in the gases, that is

to say, according to the temperature the oxidizing elements neutralize a part of the power of the reducing ones, the action being more and more energetic, with the increase of the temperature.

Then, for every degree of saturation, there is a maximum temperature at which the gas can be applied successfully to do reductive work, over which the oxidizing elements should be more powerful than the reducing, and final oxidation would take place.

Consequently the higher the saturation degree of a gas, before entering the reducing furnace, the lower is the temperature at which it can be applied, and vice-versa; on the other hand, as the reducing affinity and velocity of reaction increases with the temperature in a somewhat hyperbolic curve, the employment of low temperatures as a consequence of high saturation degree, or abundant oxidizing elements in the gases, means not only very large volumes to be circulated on account of its chemical composition, but also a very long time of treatment due to its temperature, circumstances which embody a costly and impracticable method.

Producer gas, although satisfactory for general industrial purposes, is a poor reducer, having the two defects cited above, *i. e.*, that it emerges from the producer with a high saturation degree and besides at a lower temperature than the maximum desirable for reduction corresponding with its composition.

Some direct processes, undertaking the reduction with producer gas, employ the expedient of heating up the gases before its entry into the reducing furnace, and endeavor by this method to increase its reducing power. In the majority of cases this is a costly expedient, if not a prohibitive one, disregarding other defects.

A practically complete reduction of the iron ore, on an economic base, and as far as the quality of the reducing mediums are concerned, can be effected industrially only by the use of pure reducing gases, emerging directly from the generating agency at the proper high temperature, in order to enter the reducing furnace without a preparatory heating.

It is well known there are great difficulties encountered in the working of producers tending to generate gases containing little or no oxidizing elements, and in working at high temperature; and that there is needed special if not selected coals.

Producers working with coke, and hot blast, in a similar way to a blast furnace, slagging the ashes, have been tried for other industrial uses and some satisfactory results have been obtained; but it must be also borne in mind that special cokes derived from special coals, in determined circumstances and locations, cannot be considered other than exceptional, and seldom serve the purpose of the direct process, namely, the possibility of using poor or low-grade fuels.

The present methods of manufacturing iron and steel have confined the producing centers to the vicinity of proper coal; meanwhile other localities and centers, today dormant, contain both rich iron ore deposits and fuels of different description from those necessary for our blast furnace requirements, some of them rich fuels, some others poor, but barred today for the smelting of iron ores.

It is not necessary here to review the different types of ordinary gas producers that are successfully working in many industries and satisfying the requirement expected from that class of apparatus today. All of them are well known, and although their heat efficiency is highly acceptable and good for what they are usually applied to, the composition of the gas generated is far from answering satisfactorily the indispensable conditions required for the special task of an effective and economic application to the reduction of iron ores, for the reason already expressed. For these same reasons it is considered utterly impracticable to make a good reducing gas in large units through the medium of present day industrial producers. In this connection a method for the generation of reducing gases, which it is believed would solve entirely this side of the problem, is dealt with later in detail and can be applied with advantage not only to the usual coking coals, but to practically any obtainable fuel, like lignites, peat and coal mixtures, oil, and tar, gasifying them into fixed or permanent gases, practically without oxidizing elements and cracking gases, which tend to decrease its reductive properties.

The method of gasification tends to a practical realization of large units to cope with the huge production necessary for any industrial development of this kind, if this latter can aspire to take a prominent position amongst our already well-developed methods of steel manufacture.

Gasification or Atomized Fuels.

Since the first practical application of burning powdered coal, many attempts and processes have been put forward in order to use the same fuel for generation of industrial or producer gas. However, at the present moment, so far as the knowledge of the writer is concerned, none of the trials made has given enough satisfaction to justify its adoption. To cite only those receiving more or less public report, Gobbe, in Belgium; De Laval in Sweden, Junquera in Spain, Marconnet in France, and Allis-Chalmers (Hirt producer), in United States, have shown that the resulting gases had approximately the heating value of blast-furnace top-gas, containing a high percentage of CO_2 and partially decomposed hydrocarbons, having a relatively low calorific value when cooled, and keeping a great part of the original powdered coal in suspension as powdered coke.

The methods of processes put forward can be divided into two groups, namely: (*a*) One-step processes and (*b*) two-step processes.

The one-step process consist in introducing a current of air into a chamber with the theoretical quantity of powdered coal to form producer gas by incomplete combustion. Thus all the fuel is first subjected to a rapid distillation; the air introduced for the incomplete combustion of the whole fuel is generally more than that necessary for the complete combustion of the contained volatile matter, with the result that these volatiles are the first to burn. A small amount of the fixed carbon also is consumed, a high temperature is quickly produced, and the remainder of the fixed carbon, remaining as powdered coke, reacts with the products of combustion of the volatile matters, decomposing the CO_2 and H_2O into CO and H_2 respectively.

The two-step process divides the operation into two stages; the first introduces air with the theoretical quantity of powdered coal for perfect combustion, and then introduces by a second injection the theoretical quantity of powdered coal to transform the products of combustion into fuel gases. Practical inconveniences prevent the two-step process from being carried out in its theoretical entirety, as will be seen afterward.

Theoretically the same amount of thermic work has to be done in both processes to treat the same kind of coal and to arrive at the same end. Only slight differences in temperatures will result, these due to the way in which operations are carried out.

In both processes the reactions are the same as those in ordinary gas producers, with the difference that partial distillation of the coal is effected in the cool or top

zone of a common gas producer, while in gasifying powdered coal this distillation takes place in zones of high temperature. Thus dissociation of the hydrocarbons is more complete. Provision evidently must be made for this important difference.

On first impression, it seems that neither the one-step nor the two-step process is distinctly more advantageous with the exception perhaps that the two-step process, although with the slight complication of a second fuel injection and control, makes possible the employment of different kind of fuels for the first injection and the second. A second injection of anthracite, coke or charcoal may be made, which so far have presented great difficulties in the one-step gasification.

Both processes are so simple as to be considered much more handy, compact and controllable than any of the ordinary producers of standard type.

Considering the great advantage to be gained by treating raw materials with such a considerable surface action, it seems curious enough that no better results have been obtained. This in turn suggests that some theoretical reasons underlying practical requirements probably not accounted for have been standing in the way of commercial success. The very presence of large quantities of carbon suspended in the partly decomposed products of combustion making up the final gas evidently shows that complete reaction between carbon and CO_2 and H_2O has not taken place, either due to faulty conditions of temperature or pressure or a lack in time.

A gas producer working with atomized fuels, would immediately answer the will of the operator, would be easy of control, and with the modern gas recorders, thermocouples, indicators, automatic change of stoves, etc., it will require the minimum of personnel and attention.

The Reduction of the Ore.

Experiments on the reduction of iron ores, by means of carbon monoxide, and also hydrogen, at various temperatures, have been carried out by many well known authorities, and apparently in an exhaustive manner. The experiments of Sir Lowthian Bell, amongst others, are still considered as classic results and taken as examples and references in many of the later tests by other experimenters.

Notwithstanding, in nearly all the experiments published, as far as the knowledge of the writer is concerned, no special mention is made and no allowance is provided except incidentally for such important factors as velocity, pressure, number or percentage of molecules of gas in actual contact with the ore, lineal extension of contact, etc.

The purely chemical side of the question has been dealt with in hundreds of experiments; equilibrium determined, relative affinity outlined; but the purely physical aspect, the influence of the mere material working conditions, with reactions so strong as to distort the real meaning of the chemical phase, has not been put forward in a clear and distinct manner. As a consequence of this, the results of so numerous and detailed experiments can only show abstract figures, which, although fundamental, are incomplete and lacking in finality.

If a blast furnace were to lay an absolutely unknown working agency, and such an apparatus were to be designed, based on the knowledge we have of laboratory experiments on the reduction of ores, the resulting device would be a most decided failure. Not a failure because the laboratory results are wrong, but for the reason that they do not show, in their description and published reports, the exact conditions under which those experiments have taken place. The application of these incomplete data from laboratory results, on an industrial scale, has been the main cause of all the direct process failures.

As we have in the blast furnace a practical apparatus for reduction—in reality the only reliable one we possess today—showing steady and unvarying work in the performance of its duty, we are compelled to draw certain inferences from this practical example, due to the lack of other independent information, in order to compare its practical results with the probable ones that should be obtained in the direct process. The only way to accomplish this end is to reduce the conditions of both to a common measurement, if this can be done with two such different processes.

In a blast furnace, the main bulk of the reduction is carried out in the so-called gas reduction zone, between the top and the 10000 deg. C. zone. Within this space, about 90 per cent. of the oxygen of the ore is removed by the action of the circulating reducing gases alone, which gases are generated at the bottom of the furnace, or tuyere zone. In reality this zone does not represent exclusively the proper gas reduction zone, but the joint length of the preparatory or pre-heating and the gas reduction zones, as practically no reduction starts before te hore has been heated up to at least 350 to 400 deg. C.

The iron ore constitutes about 25 per cent. to 28 per cent. of the total volume of the charge; the rest, of from 75 per cent. to 72 per cent. is occupied by the coke and the limestone together.

Under these conditions, the iron ore can be considered as floating in separate lumps, within a moving mass of coke and limestone of different sizes and shapes and is surrounded by these practically inert solid bodies, non-plastic and non-adhesive in character, which assist in the maintenance of a free passage and an even distribution of the gaseous current upon which the phenomena of reduction depend.

The pieces of ore in their movement towards the bottom of the furnace are subjected under most favorable conditions to the reducing effect of the passing gases, presenting their downward half surfaces to the full direct action of the ascending gaseous current. The increasing successive diameters of the furnace in that first zone and also the unequal movement of descent oblige the lumps composing the charge to take different alignments or groupings, resulting in a continuous change in the position of their axes. This movement gives an even exposure of the different surfaces to the action of the gases, and the effect can be considered as uniformly felt on the whole surface of each lump of ore during its passage through the gas reducing zone.

When the reduction begins in a lump of ore, the outer surface is first attacked, forming a film of sponge iron, and the following reduction work is upon successive new unexposed surfaces lying underneath the already reduced crust. This work is not only a chemical action but is also a physical work, requiring the penetration of the gaseous current through the porous diaphragm formed by the spongy iron previously reduced.

At each successive step the reducing gas has to penetrate through thicker and thicker layers of the porous diaphragm, which naturally increases the resistance to the passage of gas, not only inwards but outwards. When the combined resistances to free passage through the interstices of the charge and to the passage through the pores of the diaphragh is very marked, the reduction would practically stop at a certain depth of diaphragm, and the lump of ore would be reduced completely or in-

completely according to its maximum diameter. The time taken to reach the maximum thickness is then a problem of penetration.

On the other hand, so far back as in 1871, Thomas Whitewell, the inventor of the well-known heating stoves in England, experimenting with other ends in view, with different blast temperatures and different volumes of air injected in blast furnaces, confirmed by practical experiments the fact already observed by others that within relatively wide limits "The increase in production was directly in proportion to the increase in the amount of blast thrown into the furnace..." or in other words, to accelerate the time taken for reduction is nothing more than a problem of bringing more volume of gases into contact with the ore in the unit of time, but of course, without exceeding the economical limits of gas circulation per unit of charge reduced, according to the general dimension of the furnace.

Two Elementary Laws.

These two important points closely correlated one to another, are the ones upon which hinge the whole reduction problem and can be summarized in the two following elementary laws:

(1) That in reactions between solid and gaseous materials, the rate of reaction, within certain practical limits, and assuming an even composition and temperature is, at any moment, directly proportional to the velocity with which the gas impinges and is removed.

(2) That in cases where the surface action is essentially modified by the interposition of a porous diaphragm, the velocity of replacement of the gas molecules able to reach the new unattacked surfaces is at any moment, a direct function of the Law of Penetration.

Continuous Melting of Sponge in Primary Electric Melter.

Electric furnaces are not considered unanimously by iron metallurgists as the most economical and practical agency for melting operations. The good results obtained by some users are not confirmed by other less fortunate operators. The final results are always shown and used in a gument, but the causes of economic failure, are not often stated, and less often corrected. In every existing process, there are unavoidable losses, together with avoidable ones, which are not always apparent to casual observer. The electric furnace melting operation has relatively few items to deal with—power, repairs and electrodes. We have today reached nearly a standard type of furnace with what appears at first sight, slight variations in its mechanical details, but notwithstanding this, big differences exist between operations carried out in two works, under similar conditions.

To cite a practical example, in a paper read by R. G. Mercer, in London, May 8, 1919, at the meeting of the Electrical Engineers of England, entitled "Electric Furnaces in the United Kingdom, 1918" and based on official data collected by the Ministry of Munitions, it is cited that while the actual consumption of graphite electrodes was, with a certain make of furnace, 6.5 pounds per ton of steel in the ladle, starting with cold materials, and a power consumption of 890 KWH, as an average for a full period of over five and a half months, the nearest approach by another well-known make was 13 pounds with economizers, and the general average consumption, under what was considered fair conditions, was nearly 30 pounds, without economizers. The existence of such remarkable differences in a known art indicates that there is something wrong somewhere, which must be corrected.

Index to Mill Supplies

This Directory is published in the interes our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

In a second paper read at the same meeting, another distinguished engineer published the causes of electrode waste and the results obtained by him in his experiments after long trials with large-sized furnaces. He finally found that from 60 per cent to 75 per cent of the electrode consumption was due to its exterior combustion, inside and outside of the furnace, caused by induced air currents, coming from charging doors and spouts and leaking afterwards through the roof, around the electrode glands. The adoption of an air-tight economizer, after various attempts, resulted in the consumption being maintained at the low figure already cited, which corresponds to less than 7.5 pounds of graphite electrodes per 1000 KWH.

On the other hand the fact of consuming more electrodes does not mean merely the expenses corresponding to a few more pounds of graphite. The hot gases leaving take heat from the furnace, requiring more current, which has to pass through thinner electrodes with greater resistance, meaning still more power. The time of treatment is also affected, and the cost per unit increased, while the lining is apt to suffer more from sudden contractions and expansions, producing cracks and internal corrosion, thus increasing the maintenance charges. Therefore a simple statement that a certain electric furnace consumes more or less electrodes of the same kind than another furnace, disregards entirely other important items entering into the consideration.

The operator of one furnace has his reasons for being satisfied and for praising electric-melting generally, while the user of another is displeased and will condemn it, with apparently good reasons, convinced that he is right. Personal experience and views contradict observed facts and fundamental reasons, and this explains the diversity of opinion that we hear. Therefore, without going into details, it is not possible to present the question at issue at its real face value.

With best practical conditions for a good and intensive reductive work, the sponge iron has to be delivered by the reducing furnace at about 950 to 1000 C. This temperature represents already about 50 per cent. of the total heat necessary for its melting and overheating to 1500 C., which applies also to the gangue and flux which may be added to form a suitable slag. That there is a great advantage in proceeding immediately with its melting is at once apparent. On the other hand, the spongy iron is extremely oxidable at this temperature, and its introduction in a furnace where an oxidizing atmosphere is prevalent, as for instance, furnaces of the open hearth type would lead to great metal losses, imperilling the economic advantages gained in previous steps. Under these circumstances, the employment of electric heat appears to be better justified, as no sensible oxidation would take place.

The Product.

Finally, with regard to the characteristics and quality of the final product obtained by melting sponge iron, the matter has been discussed at large by authorities on previous occasions. It will be interesting, however, to mention briefly the action of sulphur and phosphorus in the process of smelting. The sulphur in the iron ore can be practically eliminated in the oxidizing preheating operation, while the sulphur in the fuel should be converted at the high temperature into sulphur dioxide whose partial pressure during the reduction of the ore would be too low for dissociation at the temperature at which the reduction works.

The phosphoric acid, generally present in the ores in the form of calcium phosphate, is neither dissociated nor reduced by the reducing gases at any temperature. It should pass unchanged to the primary melter, where the necessary conditions for the phosphorization of the metal do not exist, or can be prevented.

The metal from the primary melting, even under the most unfavorable assumptions, would require the minimum of refining for a high class finished steel.

MONTREAL AND CANADIAN COAL.

The following, from the City Fathers of Montreal, shows a commendable interest in a Canadian industry. As the Montreal district is once more being served by coal from Nova Scotia to a large extent, as was the case before war conditions intervened, Montrealers can speak with conviction and with authority on such a matter.

"If Canadian coal mines were operated more intensively the Canadian people would benefit by a reduction in the cost of that fuel, and the Canadian laborer would benefit by having more work to do, according to a resolution adopted by the City Council yesterday The motion further suggested that the attention of the Federal authorities be again called to this important matter.

"It was accordingly proposed by Ald. Elie, and resolved as follows:

Whereas a very large proportion of the coal consumed in Canada is imported from the United States;

Whereas,owing to the duties levied on coal, to the high rate of exchange on our currency in the United States, to the increase in the cost of labor and to the heavy freight charges, this fuel now costs more than a few years ago;

Whereas the operation of coal mines in Canada would have the beneficial effect of reducing the price of coal, of providing employment for the Canadian workmen at a time when many of them are out of work, of promoting the operation of Canadian railways and of keeping in the country the large sums of money expended for the purchase of coal;

That, for the reasons above set forth, this Council requests, as it already did on the 18th of March, 1920 the federal authorities to further, by all possible means, the intensive operation of Canadian coal mines.

"In reply to a question by Ald. Quintal, the mover of the motion said the Federal authorities had already brought about an improved state of affairs since the adoption of the motion in 1920. Last year several thousand tons of New Brunswick coal were brought to Montreal, and instructions had been given that Canadian coal be used in heating government buildings during the current winter."

IRON AND STEEL INDUSTRY FOR SOUTH AFRICA.

The establishment of an iron and steel industry in South Africa is under contemplation, according to a report received from the U.S. trade commissioner in Johannesburg. The Union possesses large resources of high grade iron ores, but the development of the industry has been hampered because lack of a supply of coking coal in commercial quantities rendered the erection of blast furnaces for the manufacture of pig iron impracticable. The invention of a new process has now obviated this difficulty. Experts who made a recent survey estimated that pig iron can be produced at a cost of 17s. 6d. per ton.

-:- EDITORIAL -:-

WHERE ARE THE LEADERS?

Canada's iron ore problem is ever with us. Even the general public seems to be awaking slowly to the fact that there is something undignified and economically unsound in our present complete dependence upon outside sources of supply. Still, this conviction is not yet general enough to force upon our political leaders decisive action in the matter. Indeed, it is doubtful whether the solution of the problem rests mainly upon governmental action.

Our législators are unable to act in the matter because they lack a mandate from the public. Those that are selfishly interested are unable to act effectively for a different reason. Their counsel is divided—in fact they have no common council. Each goes his own way, irrespective of the rest, with an eye more for his special and immediate interests than for the general and final good of the iron industry. Thus one group want a bonus on iron ore; and though they deserve such help, cannot get the moral support of the industry as a whole, and have not the means themselves of convincing the public. Another group, not actively interested in Canadian ore, are mainly concerned in preserving a sufficiently high tariff to permit a profit on Canadian iron made from American raw materials. The third group, down by the sea, are ready to meet international competition, provided their conditions of operation are not unduly hampered by artificial restrictions. Fortunate in their natural resources, they do not heed the cries of their less fortunate brothers inland. Then there is a miscellaneous crowd of others interested—owners of coal and iron mines, actual and potential; owners of water powers; national economists; inventors of processes for steel and iron production, and so on.

It has been stated and generally accepted as a fact that our iron ore problem is a national one, well worthy of the nation's serious attention. The reasons are so obvious that they need not be re-stated here. How can the force of public opinion, and the full effect of national effort be brought to bear on the problem? Certainly not by the efforts of the individual companies and individuals concerned. These efforts will be of little avail, as they are bound to be in diverse directions. If they are to have any effect, they must be all in the one direction. At present the public hears one story from the east, and a different story from the west. Little differences are aired in public. There is no unanimity, and no common policy. A provincial outlook has obscured the national aspects of the case, and we all drift along, we know not whither.

Our steel and iron industry is a large factor in our industrial system; in fact it is the largest single factor of all. Its voice is, no doubt, heard indirectly through the medium of the Canadian Manufacturers' Association, modified by and attuned to the voices of a hundred other industries, any of them less important than itself, and many of them subsidiary to itself. This association provides, no doubt, a means to certain ends desired by the iron and steel producers. But in our opinion, its chief use at present is to point out an opportunity of which advantage has not yet been taken, and to provide an object-lesson much needed by the leaders of our iron and steel industry.

The Canadian Manufacturers' Association holds in sympathetic union and co-operation men with such diverse interests as automobiles and asbestos, carriages and confectionery, guns and gramophones, pork packing and perfumes. A common interest keeps them united, and the differences of opinion that must continually arise are composed well out of sight of the public. So powerful has this united body of heterogeneous mortals become, that quite fanciful attributes are commonly ascribed to it.

When the Canadian Manufacturers' Association, with such a diversity of individual interests, can find sufficient common interest to hold its members together so firmly, and to accomplish so much as it does in their interest, there is no shadow of a doubt that the iron and steel men of Canada are warranted in a belief that their common aims would be served by an Iron and Steel Trade Association, and that their differences would sink into insignificance. Let them discard the present parochial points of view, and the ends attainable by co-operation will come clearly into perspective. Let them adopt a national point of view, and the value to Canada of their co-operation will stimulate them to effort that will ensure progress and success.

We are confident that there are men of vision and sound principle among our iron-masters. Let them assume the leaderships where leaders are now lacking, and build up an iron industry worthy of our country.

THREATENED COAL STRIKES.

The production of iron depends essentially upon the production of bituminous coal; hence the readers of "Iron and Steel of Canada" will have followed with interest and concern the progress of negotiations between operators and miners in the fields that supply Canadian furnaces and mills.

It has been asserted by some and denied by others that the American continent can afford to ignore trans-Atlantic affairs. It would seem that the coal miners of the continent are divided in their opinions on this point. The coal strike of last summer in Britain was a test of strength between the general public and the organized miners, the mine owners being merely non-essential intermediaries in the dispute. The miners returned to work in mines still privately owned, but with enough concessions to salve their pride. They are now, under pressure of necessity, doing each a full day's work, and Britain alone of coal producers has an export trade that is mounting by leaps and bounds.

The miners of Nova Scotia have profited by the lesson taught in Britain. They have naturally objected to the reduction of their wages from war-time levels, and have used every legitimate means at their command to prevent it. But the force of circumstances has been too strong for them. The coal companies have had to meet the falling prices set by their competitors in the United States. This has meant either lowering their costs or closing their mines, since their profits have never been unreasonably high, and will now stand little, if any, reduction. The final result of repeated conferences between operators and miners has been a compromise that is much to the credit of both. The miners' representatives, (and through them, we trust, the miners themselves) have consented to a reduction of wages that are obviously not warranted under present conditions. The owners have agreed to wages that are considerably in advance of those prevailing in 1914, and indeed in advance of those officially awarded by the recent arbitration board, but still will allow them to operate at a profit. Thus the production of coal, profitable to miners and owners alike, continues, and there is avoided the disaster of closed mines, which would be serious enough for operators, but still more serious for the miners.

Unlike Nova Scotia, Alberta is much closer to Indianapolis than it is to London. Thus it is not altogether unnatural that the spirit and conclusions of the United Mine Workers headquarters should carry more weight in our western coal field than does the experience of the British miners. It seems probable, at this date, that the Union miners of both the United States and western Canada will go on strike on April 1st. What can be gained by this, heaven only knows. What will be lost, is plain for everyone to see. If there were some fundamental principle at stake, as during the strike in Britain, one could understand the position better; but John T. Lewis has formulated no such programme as the "nationalising" of mines upon which the British leaders staked their reputations. The point in dispute is apparently wages alone, and that is a matter for fair-minded discussion, and if need be, arbitration.

Where the production of an essential commodity like coal is concerned, a general strike is essentially an appeal to public opinion. In Britain last summer it was lack of support from the public, not any action of the mine-owners, that sent the miners back to work. True, the owners made concessions to the miners, but no more than was due them, and most of it "qui pro quo" at that. The public mind on this continent is not so well known for shrewdness and fairness as is the British. But we are confident that if an appeal to the public is made by means of a strike on April 1st, the public will finally come to a judicial decision, and the blame for an international calamity will be put on the shoulders where it belongs.

SCIENTIFIC RESEARCH.

The Advisory Research Council at Ottawa has just issued a brochure of twenty pages entitled "Research and the Problems of Unemployment, Business Depression and National Finance in Canada." The title suggests something compendious; but the twenty pages are brief and to the point, as befits a dissertation on scientific facts, intended for wide-spread and popular distribution. We wish to outline here the history of the movement of which this bulletin forms a part.

Three years ago there was first presented in public by the advisory Research Council a proposal for the establishment of a National Research Institute at Ottawa. This met with a storm of opposition. Universities feared their prerogatives (and funds) might be curtailed. Students of public administration foresaw a further waste of public resources in yet another government department. Misanthropes saw our once-vigorous researchers waxing fat on soft government jobs, with initiative gone and progress long forgotten. Honest fears were added to vague feelings of distrust and (it was whispered) even personal envy and private spite, to bring the project into a disrepute that was widespread among the technical and general public.

The gentlemen who had formulated the idea refused to be intimidated, or even gravely concerned by the coldness with which their proposal was received. They had studied long and hard before reaching their conclusion, and were prepared to stick by it. They probably realized at this time that their seed had been sowed on ground they had failed to till sufficiently; still they were ready to prepare the ground further and sow again, before despairing of a crop. Incidentally it may be remarked that few among our men of science realize how formidable and intricate a task is public propaganda, until enlightened by some such experience as this.

Fortunately, the innate persistence of the researcher is shared by the members of our Advisory Research Council. They have set out to educate the public to the need of research on a national scale and for national objects, and to convince it of the soundness of the scheme they have proposed. Most of, if not all, our universities are now satisfied that the National Research Institute will not duplicate their work; nor

will it undertake research that should more properly be conducted within college walls. Our manufacturers now understand more clearly the service the Institute will be able to render them. It has been pointed out, too, that the researcher seems to have a kind of auto-inoculation against the energy-destroying diseases that usually attack government employees. The progress of this propaganda is well marked by the support given by the Commons in Ottawa during the last session, to the bill to create a Research Institute. Possibly it is fortunate that the Senate threw out the bill. It seems as if our House of Commons had, for once, preceded the public in its support of a progressive measure; now the public may have time to catch up.

It says much for the soundness of judgment and forbearance of the Advisory Research Council that they have refused to use the $100,000.00 voted them last autumn in the face of the ill-timed and short-sighted economy of the Senate's veto. As an expression of the Commons' faith in the judgment of their scientist advisers, this was acceptable; but as the means of erecting and equipping a Research Institute, it was hardly adequate. The vote might easily have been considered an earnest of more to come, and it would have been quite permissible to proceed with the establishment of the Institute on this basis. Wiser and more far-sighted counsel prevailed, and the education of the public proceeds apace, by means of public addresses, press notices, and now the present pamphlet.

The discussion and controversy of the past three years have no doubt modified somewhat the original ideas of the sponsors of the National Research Institute. This is salutary, and indeed necessary. We hope that the present legislature will see to it that a new bill is presented and passed, to found and maintain what has now been satisfactorily demonstrated to be a national economy and a national necessity.

EDITORIAL NOTES.

Ontario's Iron Ore Deposits.

Mr. Flaherty's paper in this issue is the result of a personal experience in the locating, exploring and developing of iron are deposits throughout Ontario such as it can seldom fall to the lot of one man to accomplish. No one has had a better chance than he to observe the facts of Nature involved, and his conclusions are well worth attention. The reserves of iron ore that he enumerates present a sum-total that should, and must, stimulate effort toward their utilization.

On one point we beg to differ from Mr. Flaherty. We wish to point out that the small amount of diamond-drilling done in Ontario as compared with the iron districts across the border is mainly a *result* of our failure to find merchantable ore, rather than a *cause* of it. Drilling in Minnesota has been an effective and comparatively cheap method of locating ore-bodies of merchantable grade. Drilling in Ontario has usually disproved the existence of commercial ore-bodies, though in a few isolated cases the issue is in doubt.

Production Costs in Australia.

Nowhere else in the world does the trades union ideal of complete social control come so near to realization as in Australia. The government and opposition there represent moderate and extreme branches, respectively, of organized trade unionism. Much that is good and of permanent value has been accomplished by these administrators; but there are some features, less admirable, that present a warning to us on this continent.

Two contemporary Australian journals bewail the fact that their iron and steel industry, which was built up and flourished during the war time, is in danger of extinction on account of competition from India and Europe. The Australian industry is based upon cheap supplies of coal and iron ore, both of excellent quality, and enjoys as well the protection of a tariff. Still, our contemporaries explain, the present per capital production of the Australian labourer and artisan is so ridiculously low that his overseas competitors, thousands of miles away and less favoured by Nature, can outdo him. The lesson is plain to read.

Banking of Coal in Cape Breton.

A contributor to the Bulletin of the C. I. M. & M. says of the wage question, which is now seriously affecting the coal industry in Nova Scotia, that he would be inclined to take a chance, strive after a compromise for a twenty five per cent reduction instead of thirty-five and then give orders to work all collieries full time. Then with a million tons of coal on bank he would be ready to supply the extra demand sure to follow in the event of a strike in the bituminous mines of the United States.

This solution of the present problem is one that might have good results for both employers and employees. It is a solution of course that places the risk on the employers; but they have to take such risks at all times. The surest thing about coal mining is that the operators will pay the wages that they agree to pay.

That the production of coal in Nova Scotia should be maintained at capacity is much to be desired. Provided the operators believe they have a reasonable chance of making a profit on operations they will doubtless endeavor to produce large quantities. Faced by poor markets and high costs they are unwilling to take chances. If the costs were reduced to a considerable extent there would be some incentive to mine coal now, and take chances on future markets; but to mine coal at high cost this year is not an attractive enterprise.

Publishers' Announcement

The publishers of Iron and Steel of Canada take pleasure in announcing that they have been fortunate enough to secure the services of Mr. JOHN THOMAS HOYLE, as director of extension courses for the training and education of apprentices in all the industries served by the journals issued from the Garden City Press, Gardenvale, Que. They feel that this is an important step in the history of their organization and in its development along the lines they have planned.

Mr. Hoyle, who entered on his duties at Gardenvale on the 1st of this month, is a Canadian. He was born in Hamilton, Ont., and started his connection with the publishing business by serving as newscarrier and "devil" on the Hamilton Evening Times. He received his education at the Collegiate Institute, Hamilton; at McMaster University, Toronto; and at the University of Rochester, Rochester, N.Y.

Mr. John Thomas Hoyle

In all departments of the publishing business, whether editorial or mechanical, Mr. Hoyle has had a singularly ample and varied experience. Until recently, he was professor of Editorial Studies and head of the Department of Printing and Publishing at the College of Industries, Carnegie Institute of Technology, Pittsburgh, and was on the lecture staff of the Library School, Carnegie Library, Pittsburgh. Among the other positions which he has occupied may be mentioned those of Textbook writer and chief of the editorial department, International Correspondence Schools, Scranton, Pa., Manager Textbook Department, International Correspondence Schools, New York City; Department Editor, "The Grit", Williamsport, Pa; Managing Editor, "The Fra Magazine" and "The Philistine", East Aurora, N.Y.; Vice-President of the Roycrofters and literary advisor to Elbert Hubbard.

Among the works which Mr. Hoyle has edited are the following: "The Complete Writings (in fourteen volumes) of Elbert Hubbard; A Roycroft Anthology; In Memoriam; The Liberators; In the Spotlight; The Philosophy of Elbert Hubbard; The Four Minute Essays (in ten volumes) and The Crane Classics (in ten volumes) of Dr. Frank Crane; "Good Hardware", Aspinwall, Pa; and "The Winged Head", Pittsburgh.

Mr. Hoyle is the author of numerous articles in magazines and technical journals. He is also joint author of the Complete Advertising Course, International Correspondence Schools, and Standard Apprenticeship Courses, United Typothetae of America.

It will thus be seen that, in adding Mr. Hoyle to their organization, the publishers are adding one whose almost unique qualifications cannot fail to result in a great accretion of strength and efficiency to the entire organization in practically all its branches. His wide experience in the preparation of manuscript and in the artistic translation of manuscript into type will materially assist in the publishers' efforts to build up at Gardenvale a corps of copy producers, typesetters and pressmen second to none.

THE TREATMENT OF CARBON MONOXIDE POISONING.

Carbon monoxide poisoning is one of the most widely distributed and most frequent of industrial accidents, says the U. S. Public Health Service. The gas is without color, odor, or taste. It is an ever-present danger about blast and coke furnaces and foundries. It may be found in a building having a leaky furnace or chimney or a gas stove without flue connection, such as a tenement, tailor shop, or boarding house. The exhaust gases of gasoline automobiles contain from 4 to 12 per cent of carbon monoxide, and in closed garages men are not infrequently found dead beside a running motor. A similar danger may arise from gasoline engines in launches. The gas is formed also in stoke-rooms, in gun turrets on battleships, in petroleum refineries, in the Leblanc soda process and in cement and brick plants. In underground work it may appear as the result of shot firing, mine explosions, or mine fires, or in tunnels from automobile exhauts of from coal or oil burning locomotives.

Carbon monoxide exerts its extremely dangerous action on the body by displacing oxygen from its combination with hemoglobin, the coloring matter of the blood which normally absorbs oxygen from the air in the lungs and delivers it to the different tissues of the body.

Oxygen will replace carbon monoxide in combination with hemoglobin whenever the proportion of oxygen in the lungs is overwhelmingly greater. Therefore:

1. Administer oxygen as quickly as possible, and in as pure form as is obtainable, preferably from a cylinder of oxygen through an inhaler mask.

2. Remove patient from atmosphere containing carbon monoxide.

3. If breathing is feeble, at once start artificial respiration by the prone posture method.

4. Keep the victim flat, quiet, and warm.

5. Afterwards given plenty of rest.

Canadian Ingersoll-Rand Company

One of the largest metal working industries in Canada.

The real history of compressed air as a factor in the industrial transmission of power dates from the year 1871. In that year the two pioneer concerns later united in the firms now comprised in the Ingersoll-Rand and Canadian Ingersoll-Rand Companies, were established. Starting with the rock drill and the need for compressing machinery which its invention brought about, the Company has been identified with practically every important development in the production and use of compressed air during the past half century.

The history of the Ingersoll-Rand Company is therefore synonymous with that of compressed air and of modern machine mining which the development of the air-operated rock drill made possible.

The Canadian Ingersoll-Rand Company, or Canadian Rand Drill Company as it was then called, was established in Sherbrooke in 1889, with a total staff of some twenty men, using small rented premises (about 40 x 60 feet) in a building on the Magog River, owned by the Jenckes Machine Company.

Increased volume of business required larger quarters, and both Companies moved later to a large plant on the banks of the St. Francis River. The Rand Interests used the Jenckes foundry and power and occupied a space of about 30 x 160 feet, at this time. The business expanded rapidly and about 1900, the Company finally moved to the present site in the upper part of the town and built its own plant.

The close association of the Canadian Ingersoll-Rand and Jenckes Machine Companies finally led to the taking over of the latter Company's plants, patents, drawings, patterns, fixtures, good will, etc., in January 1918, since which time the majority of the lines formerly manufactured by the Jenckes Machine Company have been produced under the registered trade name "CIRCO."

"Jenckes Plant."

The property secured from the Jenckes Machine Company, included a well equipped grey iron foundry, pattern shop, structural shop, two machine shops, a centrally located power-house and numerous storage buildings of modern construction.

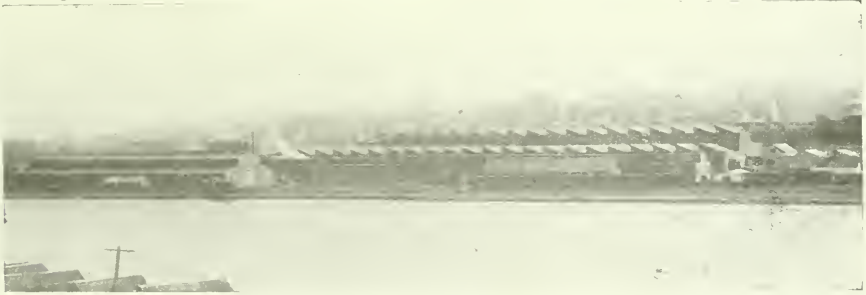
The Jenckes Plant was operated continuously until May 1921, when it was decided to move some of the machine for equipment to the Upper Town Plant, so as to centralize manufacturing processes of the same class, as much as possible.

Paulson Barking Drums, and Bark Presses, Steel Frame Chip Screens, etc., are products of the structural shop located at this plant, and the largest shop, known as number "15" is equipped with a very large engine lathe, roll turning lathe, Lobdell Grinder, Roll Grooving Planer and other equipment for the rapid and accurate production and refinishing of chilled iron rolls, such as are used in rubber mills, paper mills, etc.

Sidings enter the yards and various buildings, providing excellent shipping facilities.

Site and Layout of "Rand Plant."

The "Rand" or main plant, occupying 23 acres, is located on slightly sloping ground, separated from the Magog River by the Station and Yards of the Canadian Pacific Railway, from which five parallel sidings enter the yards and buildings. Iron, coke and heavy foundry supplies, are received in the upper yard at the cupola level, and the finished product is shipped from the lower levels. Sherbrooke has the advantage of being served by four railways, being on the main line of the Canadian Pacific Railway from Montreal to St. John, the Montreal-Portland main line of the Grand Trunk, in addition to being the Northern Terminus of the Boston and Maine, and the headquarters of the Quebec Central Railway.



Splendid Example of Modern Mill Construction.

Inter-switching facilities are good, and good relations between the Company and the Railways, make possible much more prompt railway services than can be obtained in large centres. Electric power is cheap, and abundant.

Pattern Shop and Pattern Storage.

The Pattern Shop of any plant should be in close connection with the foundry, and in the case of the plant of the Canadian Ingersoll-Rand Company, the pattern shop is placed between the foundry and main office, so that it is easy of access both to the Engineering Department and foundry foreman.

The building is of brick construction, single-story, measuring 60 x 100 feet, well lighted all round, the natural lighting being helped by the fact that none of the neighboring buildings are close enough to obstruct the windows. The equipment is complete, including swing cut-off saws, band-saws, nip saws, buzz planers, sanders, emery discs, cylinder sanders, wood-turning lathes, etc.

A special feature of the layout is that the benches

are arranged cross-wise to the windows; this arrangement has advantages both for lighting and for general convenience. Iron tables, with surface planed flat and edges straight and square, are in use for lay-out work, and have proved of very great value.

There are four pattern storage buildings. All patterns are stored on shelves and are easily located by means of a simple numbering system. Both patterns and shelves are numbered.

Foundry.

As previously mentioned, the sloping character of the site of the plant has been used to advantage in the placing of the various buildings. Thus the foundry is on the higher level, and all materials used in the cupolas are received in the upper foundry yard on the cupola level, so that no hoisting of materials is necessary. Sand for cores and moulds is mixed on an upper floor and supplied to the core department and moulding floor by means of chutes. The upper floor extends the whole length of the building and is used for storage of all kinds of lighter foundry supplies and equipment.

The foundry measures 102 x 242 feet, has two cupolas and is equipped with a Mumford Jolt Ramming Machine, which when installed, was the largest in Canada. The equipment of special flasks is particularly thorough, which permits of making all moulds for regular lines on a manufacturing basis. There are also smaller jolt ramming machines for core work; Tabor Roll-Over Machines for side floor work and a full equipment of pneumatic sand-rammers for bench and floor use.

The ovens for baking dry sand molds and cores, are a special feature, there being three large ovens, twenty-five feet square and two smaller ovens. The foundry is served by two cranes of fifteen and ten tons capacity and there are also jib cranes with pneumatic motor hoists in the bays and in the cleaning department.

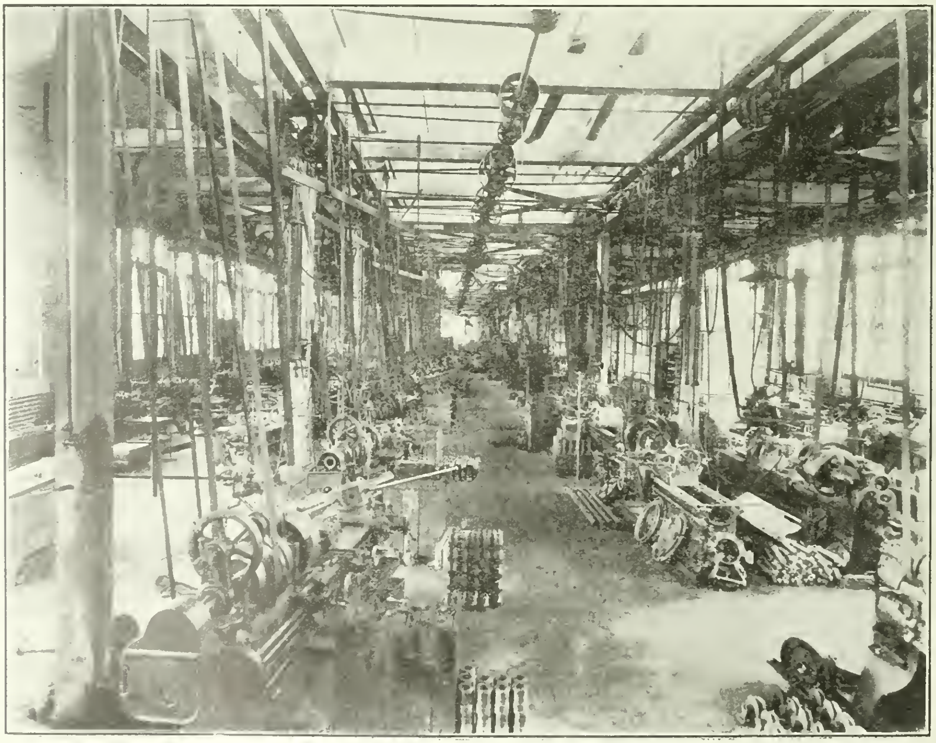
The sandblast room uses a combination of Pangborn, Sly and Ingersoll-Rand systems. This is essential, as some of the Company's products require sandblast finishing. The cleaning department also makes use of pneumatic chippers and grinders. In addition to the product of its own foundry, the Company uses large quantities of brass, bronze, malleable iron and steel castings, which are made to its specifications and analysis.

Foundry Yard.

Between the foundry and the compressor shop lies the foundry yard, in which are stored flasks and castings. The principal feature of this yard is that it is spanned by a 10-ton travelling crane, which is, of course, very much more convenient than a series of jib cranes.

"Number 2" Shop.

From this building came the largest production in Canada, of 8 inch shells, the second largest of 18 pr. shrapnel, in addition to thousands of 6 inch and 75 m.m. shells. Following the armistice, the shell machines were cleared out and stored, and the Compressor,



A Battery of Lathes in the Canadian Ingersoll-Rand Plant.

Pump and heavy Machinery Departments moved up from the original building on the Company's present site — Number 1, which is now used as a finished products warehouse. This storage building is 303 feet long by 90 feet wide and is shown in one of the illustrations herewith.

Number two shop is of one-storey construction, 562 feet long by 202 feet wide, with basement extending under the northern half, the latter used as a general store room. The type of construction is of the heaviest; to support a loading of 250 lbs. to the square foot. With a view to supplying an abundance of light, the roof is of the "saw-tooth" Monitor type, the clear height under the monitor being 40 feet with 25 feet clear height under the side bays. The side windows are of the modern wide type, so that there is no lack of daylight in all parts of the shop.

In general, the equipment of this shop comprises vertical and horizontal boring mills, lathes, drill presses milling machines, grinders, gear cutters, Potter & Johnson Automatics, etc., Compressed air is used to a very large extent; pneumatic drills in erection work, chippers and grinders for finishing up frames, flywheels, etc., compressed air jets for cleaning out deep holes in drill-press work, blowing dust off benches or machine tools, etc.

An important feature of the work is testing; compressors, pumps, hoists and dozens of other machines are very carefully tested before shipment; one illustration herewith, shows a Cameron Pump under test. This particular pump happens to be one of ten supplied to an Eastern Canada Pulp Mill on one order.

Pneumatic Tool Department.

The accuracy necessary in the manufacture of pneumatic tools is little realized by the general public; close fits are absolutely necessary and yet the tools must not be delicate, and must stand up under hard service without frequent stoppage for adjustment or repairs. For these reasons, the equipment in this department is among the most modern in the plant, and inspection is exceedingly rigid. The bulk of the raw material passing through this department is alloy steel, which is used instead of cast iron, or other material, on account of its much greater strength. The lathe work is done as far as possible on automatics, or on turret lathes, both of which are well adapted for high speed and accuracy. Milling is handled by a large battery of modern vertical and horizontal milling machines.

Forge Shop and Hardening Department.

The Forge and Hardening Department ranks as one of the most important in the whole plant. Proper heat treatment will give almost any result required in the way of toughness, hardness, etc., and the majority of the parts that go to make up the rock hammer-drill, and pneumatic tools—and a great many other products—require a very complex heat treatment.

The Forge Shop is equipped with steam hammers, bolt presses, fuel oil furnaces, coke forges, etc., but the bulk of the work of the department is in the hardening and heat treatment section. For this part of the work there are large carbonizing furnaces, oil-treating furnaces,

Variety of Work in Machine Shop.

Machine Shop Served by Railway Track.

hardening furnaces, lead and cyanide baths, brine and oil tanks, quenching jigs, etc. While no place for white collars or clean clothes, this department is one of the most interesting in the whole plant.

General Products.

It is estimated that 80 p.c. of all the air compressors and a very large percentage of all the compressed air equipment used in Canada are of Canadian Ingersoll-Rand manufacture. The Ingersoll-Rand Company maintains Branch Offices in all parts of the world and Canadian Ingersoll-Rand products are exported through their offices to various parts of Europe, Africa, Asia, South America, Australia, etc.

Through its own branches extending from coast to coast, the Company is represented in practically every important centre of the Pulp and Paper Industry in Canada and its equipment is in use by such firms as Abitibi Co., Brompton Co., Canada Paper Co., Ontario Paper Co., Laurentide Co., International Paper Co., and others too numerous to mention.

Responsible visitors are at all times welcomed and any mill executive who has an hour or two to spare when in Sherbrooke would find a trip through this plant of great interest and well worth the time required. This may be arranged in advance or by calling at the office.

HEMATITE IN SOUTH AFRICA.

In the transactions of the Geological Society, South Africa, (1921), are described the hematite deposits of the Rustenberg District, Transvaal. These were formerly thought to be sedimentary beds, representing exceptionally rich portions of banded ironstones. Now it appears that they owe their origin to a process of secondary enrichment, whereby the original layers of certain sections of the banded ironstones have been replaced by iron oxide, giving rise to solid bodies of ore made up of alternations of primary and secondary hematite layers. In this respect they are of identical origin with some of the Lake Superior hematite deposits.

The Rustenberg deposits overlie dolomite, and are overlaid by a bed of chert-conglomerate. Many million tons probably average not less than 40 per cent. of iron, but the high silica content destroys their value as potential ores of iron. However, lenticular and irregular tabular bodies of high-grade ore occur, associated with ironstone, from a few inches up to 51 ft. in thickness, and from a few yards up to 1,000 yards in length. The two main horizons containing the hematite deposits occur near the contact in the chert-conglomerate, and also near the contact with the dolomite, and the lower portion of the former has in one place been replaced by hematite, giving rise to a small irregular deposit of that ore. Analysis show the ore to be of high grade, containing from 60 to 67.75 per cent. of iron, from 0.55 to 6.32 per cent. of silica, from 0.006 to 0.05 per cent. of phosphorus, and no sulphur.

The Wages of Colliery Workers in Nova Scotia

The following is an authoritative statement, in brief, of the events to date leading up to and following the recent "Gillen award" in the Sydney coal fields. It will serve as an authentic record of the facts of the case, as well as a source of information for those who have not followed the matter closely in the daily press. — Ed.

During the year 1921 the wages paid to the mineworkers in the Nova Scotia coalfield were governed by an agreement arrived at in November 1920 between the employees and the several managements of the coal companies now merged into the British Empire Steel Corporation, namely the Dominion Coal Company, Nova Scotia Steel & Coal Company and Acadia Coal Company. This agreement was arrived at because of a mutual refusal of the men and the coal companies to accept the recommendations of a Royal Commission which enquired into the wages and working conditions at the coal mines in the Summer of 1920. At the beginning of 1920, under the guidance of a Conciliation Board headed by Mr. Clarence Mackinnon, a wage agreement had been come to which covered the year 1920. About the time when commodity prices reached the peak in June 1920 the mineworkers applied for a further increases in wages. Their action resulted in the appointment of the Royal Commission and the eventual disagreement above referred to, and in November 1920, an agreement was made which gave the mineworkers an increase of 55 cents per day, with equivalent tonnage increase to contract workers. This agreement, since known as the Montreal Agreement, expired at the end of November 1921. Under its terms the parties thereto agreed to meet in November to negotiate a new wage understanding, but by mutual consent negotiations were deferred until the middle of December. The coal companies gave notice that business conditions compelled them to ask a reduction in wages upon the expiry of the Montreal Agreement, and the mineworkers took the ground that no reduction could be accepted. At the deferred negotiations in December the mineworkers consistently maintained refusal to accept any reduction, no matter how slight, and, for this reason, the negotiations were entirely futile. The coal companies thereupon announced a reduction in wages effective at 1st January 1922, of approximately 33 percent. from the rates current in 1921. The wording of the notices announced a reduction of 25 percent. from the rates of the Mackinnon Award, the reduction being applied in this way in order to preserve the rate differentials which were a feature of the Mackinnon Award, having been arrived at by protracted negotiations with the mineworkers.

The United Mine Workers, upon receiving the notification of reduction, immediately applied for a Board of Conciliation, which was appointed by the Minister of Labor, without the concurrence of the coal companies. The mineworkers secured a temporary injunction restraining the companies from putting a reduction into effect pending a reference to a Conciliation Board, contending that the action of the companies was a violation of Clause 57 of the Industrial Disputes Act. An appeal to the full bench of judges in Halifax resulted in suspension of the injunction, on the ground that both parties having consented to meet to negotiate a new understanding, and having failed to do so, no violation of the Industrial Disputes Act could be argued. One of the judges, in a separate judgment, expressed his grave doubt of the constitutionality of the Industrial Disputes Act insofar as it undertook to regulate private business in the Provinces, but as the injunction was suspended on separate and sufficient grounds, the constitutional point was not raised in the main judgment.

A Conciliation Board, under the chairmanship of C. E. Gillen, General Manager of the Toronto Terminals Railway, was held in Halifax, the proceedings occupying almost a fortnight, and attracting widespread public attention.

The report of the Board recommended a modification of the reduction announced by the coal companies, making the reduction of the laborers' rate 25 percent. and in the other rates of approximately 28 1-2 percent. below the wage rates of 1921.

The mineworkers have voted on an unqualified question put by their leaders as to whether or not they should accept the award of the Board, and practically unanimous vote against acceptance was given.

The coal companies notified the mineworkers of their willingness to negotiate an agreement with the Gillen Award as a basis, if acceptance by the men were signified by 15th February. This resulted in another conference in Montreal, at which a compromise was effected and a second Montreal agreement reached, the terms embodying a substantial increase over the rates of the Gillen award, but a reasonable reduction from the high rates prevailing during 1921. This agreement, signed by the leaders of the mineworkers, has now gone to the miners for their vote.

ELECTRICAL PROPERTIES OF TITANIUM ALLOYS.

The electrical properties of titanium alloys have been investigated at the Rensselaer Polytechnic Institute, Troy, N.Y., and the investigation is the subject of No. 12 of the Engineering and Science Series of that institution, published by the authors, M. A. Hunter and J. W. Bacon. A summary of the results of the investigation is as follows:

The addition of titanium to iron improves the magnetic quality of the iron. The magnetization curves are invariably higher and the hysteresis losses lower than in an untreated specimen.

The action is attributed to a cleansing of the material by the addition of titanium. If additions are made in such amounts that titanium is left in the iron, the material improvement is no longer apparent. The samples will under these conditions be lower in magnetic quality than the original iron.

Good results were obtained by treating silicon-iron with titanium. These alloys gave an exceedingly high permeability and low hysteresis loss.

The ageing of the titanium-treated specimens was of the order of that of iron, though somewhat less in degree.

Alloys of titanium with nickel, copper, nickel-iron and nickel-copper were made. The specific resistance of these materials are only moderately high for additions of titanium up to 5 per cent. Beyond this point the alloys are exceedingly hard to draw. Such wires as were made can be run continuously only at low temperatures by reason of their tendency to oxidation when run at a red heat.—Iron Age.

Ontario Iron Ores.*

By R. H. FLAHERTY, E.M.

In reviewing the iron ore situation in the Province of Ontario, within the limits of a short paper, it is scarcely possible to more than merely touch upon the principle characteristics of the various ranges, together with their extent, commercial availibility, and their relation to the industrial life of the Province.

The iron ore deposits are, broadly speaking, distributed between the County of Hastings, on the East, to Bad Vermillion Lake, in the District of Rainy River.

The various ranges are so situated as to transportation facilities, by rail and water, that they are readily accessible for domestic or export shipment. Lying as they do, within economic distances from deep water navigation on the Great Lakes, and along the lines of the Canadian National, Canadian Pacific, and Algoma Central Railways, the heaviest initial expenditure that usually has to be provided for transportation of the ores of new iron ranges, is thus avoided.

The ranges tributary to Lake Superior, vary in distance from the water front from 4 miles, in the case of the Animikie range at Loon Lake, 15 miles at the Magpie, 30 and 50 miles, respectively, in the case of the Kaministiqua and Mattawin ranges, to 127 miles in the case of the Atikokan range.

In addition to the transportation facilities at hand, these ranges are within a hydro-electric power zone of great magnitude. The immense development of the Nepigon hydro power, the Kam Power Company, and the enormous reserves of water power at Dog Lake, on the Mattawin and other rivers, gives assurance of ample water power at reasonable rates, for all mining and metallurgical purposes that may be required in the Thunder Bay district.

It has been, and unfortunately, still is, the habit of Canadians to view our iron ores with scant appreciation, and to apply, equally scant investigation of their merits, and their great possibilities under development. Lack of the latter is wholly accountable for the existing situation in the iron ore industry in Ontario today. They have been content to look upon them as being too low in iron content, too high in sulphur, or being too highly silicious to be made available for furnace use in competition with the high-grade foreign ores, that are of such easy access, and can be imported free of duty, at cheap water rates. This latter is the greatest handicap Ontario ores have had to contend with; without it, we would long ago have had a prosperous iron ore industry in this Province, that would furnish much-needed traffic for our railways, employment for labour, stimulate merchandizing in all its branches, and have saved the country enormous sums of money expended for imported ores.

No virgin iron deposit can be fully explored, without the free use of the diamond drill. Less than 50,000 feet of diamond drilling has been done on Ontario deposits, while over eleven million feet of drilling has been performed on the iron ranges in the adjoining State of Minnesota. Sufficient preliminary work, however, has been done on our own ranges, in an initial way, to demonstrate the immense tonnages, and character of the ores on the various ranges. They have been sampled, tested, and subjected to such metallurgical methods, as to prove beyond doubt, their commercial availibility for furnace use.

That our own ores will be called upon, in the very near future, to supply, if not all, at least the major portion of the ores charged to Ontario furnaces, is beyond question. That we can treat and place a high-grade concentrate on the open market, in successful competition with the high-grade ores of the United States, has been demonstrated to the satisfaction of practical iron ore operators.

The fact of the early coming of a demand for our own ores, is attested by the rapid depletion of the high-grade ore reserves on the United States ranges. In that country, the distribution of ore reserves among the various furnace companies is such that, while a few of them have enough ore to last them 30 or 40 years, others have enough to last them only 5 or 6 years. This means that their low-grade ores must be resorted to, or they must look to foreign ores for their supply.

The existing situation on the United States Lake Superior ranges has led them to the employment of the most modern scientific methods of beneficiation for their low-grade ores, in order to prolong the life of the ranges. Millions of tons are being treated on these ranges, that were formerly looked upon as having no value whatever. There is scarcely an operating mine on the Minnesota ranges that is not employing some form of beneficiation.

At Babbitt, Minn. the Mesabi Iron Company have the first unit, nearing completion, of a huge plant, that will ultimately consist of 22 such units, for the exploitation of an immense area of low-grade magnetites, averaging from 20 per cent to 25 per cent. iron. Before beginning the erection of this plant, the methods to be employed were thoroughly tried out in a testing plant at Duluth, Minn., covering a period of four years, at a cost of nearly a million dollars. As to its commercial success, it is only necessary to say, that the purchasers and users in their own furnaces, of the several cargoes of the product of the testing plant, are now represented on the Directorate of the company, by five out of thirteen Directors of the Mesabi Iron Company. Their connection with the undertaking arose wholly through the character of the product, and the commercial feasibility of the methods used.

The first unit of this great plant, which is the most gigantic in the history of mining, will be in operation April 1st next and have a capacity for handling 3,400 tons of crude material daily. Owing to the low iron content of the crude material, its massive and homogeneous structure, fine grinding and sintering of the whole product is necessary, which materially increases the cost of beneficiation.

Somewhat similar, but less costly methods applied to the magnetites of Northwestern Ontario, would achieve equally desirable results, at a greatly reduced cost, owing to the physical structure of the Ontario ores not requiring such fine grinding, and only a small portion of the fines would require sintering. The higher natural iron content, averaging 38 per cent, would be greatly in their favour, so much so that a plant to produce from 500 to 1000 tons of concentrates daily, could be operated on a profitable commercial basis.

The utilization of our own ores is of such paramount importance, that the Federal and Provincial Governments would be well advised, and amply warranted in

* A paper presented at meeting of the Toronto branch, Canadian Institute of Mining and Metallurgy.

uniting to erect, and operate a unit, that could be later added to, that would produce 150 to 200 tons of concentrates daily. The product from this capacity would accumulate fast enough to provide several cargoes during a season, that could be shipped and sold at a price in competition with high-grade United States ores, that would show a good profit on the operation, in addition to being a practical demonstration that would bring millions of tons or our own ores into the market. I say this advisedly, after several years of intimate association with the various ranges, and a knowledge of the quality and character of the ores.

On the Animikie range, at Leon Lake, which has been definitely determined to be an eastern extension of the Mesabi range in Minnesota, where less than three per cent. of the known iron formation has been diamond drilled, over 4,000,000 tons of merchantable hematite ore has been disclosed, that will average from 50 per cent. to 55 per cent. iron, natural, well within the bessemer limit in phos. no titanium, sulphur negligible, high in lime and magnesia, and averaging less than 1 per cent. in moisture. This deposit is admirably situated for mining and shipping, being only 4 miles from deep water navigation at the head of Thunder Bay, were there is excellent harbourage. The deposit is at an average elevation of 450 feet above Lake Spperior, is traversed by the Canadian National and Canadian Pacific Railways, and the Hydro Electric Power Commission's transmission line.

This deposit offers an ideal site for the location of an iron furnace, where there is an ample ore tonnage to supply a 200 ton furnace for the next fifty years, with a reasonable probability of this tonnage being multiplied many times.

No better ore is to be found in the whole Lake Superior iron region, than is to be found in this deposit, and in tonnage amply sufficient to warrant large operations, either for reduction on the site, or shipment to domestic, or foreign markets.

On the Kaministiqua and Mattawin ranges, both of which are situated on the Canadian Pacific, and Canadian National Railways 30 and 50 miles, respectively, west of Port Arthur, banded jaspilites and magnetites occur in hundreds of millions of tons, that can be mined, largely as a quarrying operation, at very low cost. These ores are especially amenable to cheap concentration methods, and can be mined, milled, and a 55 per cent. concentrate landed f.o.b. cars Port Arthur, at a cost not to exceed $3.50 per ton. These figures are based on a daily output of 1,000 tons, and may be readily verified.

I append results obtained by extensive Laboratory tests, made at the Minnesota School of Mines Experiment Station, University of Minnesota, Minneapolis, and at the Laboratory of the Colorado Fuel & Iron Company, Denver, Col. from sampling done by Dwight E. Woodbridge, E.M. of Duluth, Minn., and J. D. Gilchrist, E. M. of Denver, Col.

On the Atikokan range, 127 miles west of Port Arthur, on the Canadian National Railway, the Atikokan Mine has been developed by three shafts, and five tunnels. Approximately, 11,000,000 tons of ore that will average 55 per cent. iron, natural, 2 per cent. sulphur, and 10 per cent phos. has been proved up. The output to date is 86,433 tons, averaging 59.85 per cent iron, natural, 2 per cent. sulphur, and .11 per cent phos.

On the Atikokan range, west of Sabawe Lake, some fifteen million tons of pyrrhotite ore has been disclosed by drilling operations, having an average iron content of 55 per cent. natural, 13 per cent. sulphur, and .03 per cent. phos. These pyrrhotites, when desulphurized, make an excellent furnace product. Several demonstrations have been made on sample shipments of one hundred tons and over, that gave entire satisfaction, and proved their commercial worth.

In the vicinity of Bad Vermillion Lake, there is an extensive range of titaniferous ore, averaging high in iron, that will one day be in demand.

On the P. A. & W. extension of the Canadian National Railway, there are large deposits of magnetites at Gunflint Lake, and further west, on Hunters Island, very extensive beds of banded magnetites occur, that, from surface explorations, indicate large tonnages of ore, that is quite amenable to modern methods of concentration, and is free from deleterious foreign matter. Its location near railway transportation, makes easily accessible for exploitation.

In the District of Algoma, along the line of the Algoma Central Railway, extensive bodies of siderites have been proven by diamond drilling, that average 35 per cent iron, natural. These ores have been successfully treated by calcining, and brought up to a 50 per cent. grade, by the Algoma Steel Corporation.

North of Biscotasing, on the Canadian Pacific Railway, many millions of tons have been proved to exist, that average around 50 per cent. natural iron, somewhat high in sulphur, that, when calcined, may be readily brought to a 55 per cent. grade.

On the Ground Hog River, in the same District, there are extensive deposits of magnetites, that are readily available under modern concentration methods, and are within easy distance of the Canadian National Railway.

At Moose Mountain, in the District of Sudbury, over one hundred million tons have been proved by diamond drilling, that averages 35 per cent. natural iron. Estimates of the probable tonnage in this deposit, run into very large figures.

In this brief, and imperfect summary of the Ontario iron ranges, I have endeavoured to cover the principle ranges, without going into the technical side of the iron ore industry, or the geological features surrounding it. I have, however, endeavoured to show that our iron ores are in immense quantities, that they are of a quality that lend themselves to modern methods of beneficiation, well within economic limits. Further, that they are not only capable of supplying our own wants, in the up-building of a prosperous and profitable iron and steel industry, but that they can meet the high-grade foreign ores in the open market, and show good margins of profit.

Following is the result of magnetic iron ore separation tests on five samples of iron ore taken in October 1921, from properties on the Mattawin range in western Ontario, north from Lake Superior.

The sampling was done by Mr. Dwight E. Woodbridge, E.M. of Duluth, Minn. and the tests were made by the metallurgist of the State School of Mines, at Minneapolis, Minn. These parties probably have had as wide experience in magnetic iron ore work, as any men to be found.

Because of the fact that the magnetic particles in the ore appeared to be comparatively large, it was decided to make a series of tests, on material crushed to pass a 4 mesh screen, and to complete the experiment on this minus 4 mesh concentrate crushed to under 100 mesh. The tests were as follows:

Lot No. 1.

Dry cobbing test at 4 mesh: Concentrate of cobbing product Crushed to 100 mesh:

Product	Wt. (Per Cent)	Tot. Fe. (Per Cent)	Mag. Fe.	Tube concentrate Wt. (Per Cent)	Tube concentrate Tot. Fe.	Tube concentrate Phos.	Tube tails Wt.	Tube tails Tot. Fe.
Lot No. 1.								
Crude ore	100.00	36.80	33.24	60.17	55.25	0.133	39.83	8.94
1st cobb	18.00	8.90		2.58	26.48		16.19	6.10
2nd cobb	14.37	12.86		2.83	30.82		11.54	8.46
3rd cobb	10.26	30.59		5.17	48.17		5.09	12.72
4th cobb	13.78	48.25		10.99	57.38		2.79	12.29
5th cobb	42.82	54.87		38.48	59.36		4.34	15.08
Lot No. 2.								
Crude ore	100.00	38.68	34.68	39.72	56.43	0.147	49.28	13.82
1st cobb	34.87	13.24		3.43	43.83		31.44	9.91
2nd cobb	14.36	26.48		2.65	54.87		11.71	20.07
3rd cobb	28.21	50.83		22.03	57.00		6.18	28.81
4th cobb	13.85	55.75		12.32	50.05		1.53	29.21
5th cobb	8.71	57.08		7.91	59.85		0.80	29.80
Lot No. 3.								
Crude ore	100.00	48.86	45.26	82.60	54.79	0.128	17.40	20.71
1st and 2nd cobb	4.43	36.51		2.49	51.22		1.94	17.67
3rd cobb	33.54	45.96		25.59	54.03		7.95	20.00
4th cobb	37.98	50.07		30.68	56.69		7.30	22.25
5th cobb	24.05	35.27		20.38	59.65		3.67	23.42
Lot No. 4.								
Crude ore	100.00	28.48	25.53	46.20	55.25	0.112	53.80	3.38
1st cobb	33.92	6.32		4.32	27.19		29.69	3.28
nd cobb	16.37	10.48		2.53	38.30		13.84	5.39
3rd cobb	18.13	38.05		11.98	53.73		6.15	7.52
4th cobb	15.79	54.64		14.25	59.36		1.54	10.90
5th cobb	15.79	57.23		14.73	60.42		1.06	12.81
Lot No. 5.								
Crude ore	100.00	38.86	26.18	45.08	58.75	0.139	54.92	22.53
1st cobb	30.60	20.78		3.49	56.92		27.11	16.13
2nd cobb	20.77	34.78		2.31	60.19		18.46	31.60
3rd cobb	31.88	49.67		16.50	59.66		15.30	38.84
4th cobb	10.75	55.63		7.98	60.80		2.77	40.75
5th cobb	6.00	57.61		4.87	61.85		1.13	39.36
Lot No. 6								
Crude ore	100.00	39.68	34.68	75.70	45.45	0.092	24.30	21.70
1st cobb	8.65	27.45		2.43	42.24		6.22	21.68
2nd cobb	10.81	29.03		3.47	40.19		7.34	23.61
3rd cobb	37.84	38.66		29.06	43.76		8.78	21.77
4th cobb	24.82	44.52		21.71	47.33		2.61	21.20
5th cobb	18.38	47.41		16.54	49.69		1.82	26.95

If one reads the above figures in each case in the light of the percentage of weight (%wt) they will fall into their proper proportions.

A general statement is: First, that the crude ore averages 38.1% iron, which is excellent for a lean concentrable iron ore. Second, that the *magnetite* in this crude ore averages in iron 32.3%, or, in other words, that 85% of the iron is in the form of magnetite. The rest is probably chiefly hematite, most, if not all of which, will be lost in process of concentration, passing into the tailings. Third, that the crude ore is non bessemer, averaging 0.1255% phosphorus. The probability is, that the concentrates will be exceedingly low in phosphorus, giving a special low phos. grade of ore. (It is the fact that in these particular ores, the phosphorus goes out with the gangue mineral). Fourth, that in the manipulation of this ore, coarse grinding (minus 4 mesh) is not sufficient to give best results, and that fine grinding is necessary, and that this fine grinding (except in the case of No. 6), will give a very high-grade ore, and that this grade will be not far from 60% natural iron.

Extensive experiments conducted on these and similar ores for some years, have shown that a 60% concentrate is not difficult to secure.

It seems rather evident that the tonnage of these ores, existing in the deposits sampled, and others adjacent to them, is very large, sufficient for all practical purposes; i.e., to warrant the erection of concentrating works, large enough to be commercially successful.

Memorandum Re Development of Low-Grade Iron Ores, Mattawin Range.

On this range there are to be found extensive deposits of banded and low-grade magnetites, which require crushing or grinding to concentrate the iron content.

The crude ore ranges from 30 to 40 per cent. iron content, and the concentrates from 55 to 65 per cent. natural iron. These deposits, remarkably free from sulphur, phosphorus and titanium, are so extensive and accessible, within 50 miles by rail from the harbours of Port Arthur and Fort William, that they offer an unrivalled opportunity for a profitable business in mining and marketing the ore, but more particularily for the establishment of an iron and steel industry at the Head of the Lakes. The following figures, which may be easily verified, will bear out this contention:

One of the essentials of a successful iron industry is to be sure that a sufficient tonnage of iron ore is available to keep the plant in operation, over a long term of years. In this respect, there is at Kaministiqua and Mattawin ranges, untold millions of tons of ore suitable for concentration, or beneficiation—upwards of one hundred million tons can be quarried and handled by steam shovel; this quantity is above ground to be seen, measured and tested. It is unknown how many million tons may eventually be mined, when such is necessary.

The next essential is the quality of the ore when concentrated. The following is an analysis of a laboratory test of the ore, before, and after concentration, made by Mr. J. D. Gilchrist, B.M., of Denver, Col. which gives very satisfactory results.

The ore crushed to 4 mesh, and screened to four sizes, analysis as follows.

	Iron (Per Cent)	Silica	Phos.	Sulphur
Through 4 on 6	39.6	44.15	.069	.46
6 " 8	36.6	44.20	.065	.36
8 " 20	36.7	43.0	.64	.32
20	39.1	34.5	.067	.36

The analysis of the concentrates follows:

	Iron	Silica	Phos.	Sulphur
Concentrates	58.5	14.7	.083	.14
Tailings	20.	67.0	.033	.56

Having established the quantity and quality of the ore, we have now to quarry or mine it for concentration. At the deposits under consideration, sufficient ore to provide an output of one thousand tons per day, for one hundred years, can be quarried and handled by steam shovel, thence sent to the concentrator, by cars, or conveyer; little manual labour is required, and no cheaper way of obtaining ore exists. The process of crushing or grinding the ore, differs with the kind of ore to be handled.

The following is the estimated cost of concentrating the ores under consideration, supplied by Mr. Gilchrist:

Mining, 1¾ tons 70c.	.70
Milling, 1¾ tons, 30c.	.53
Royalty, 1¾ tons, 15c.	.26
Nodulizing 40% of product, $1.50	.60
Mine and general office	.30
Cost of concentrated ore at mine	$2.39

The ore having been concentrated, nodulized or sintered, as the process may be, is ready for transportation to a market or smelter. For the magnetic separation of the concentrated ore, and for other uses, the plant of the Kaministiqua Electrical Power Company, is situated on the Kaministiqua River, about 5 miles distant, and easy of access for a power line, along the C. N. Railway right-of way. The Shebandowan River, near by, could be cheaply utilized for power to the extent of 8,000 to 10,000 H.P.

The ore deposits on the Kaministiqua range are generally within a mile of the Canadian Pacific Railway, and the Canadian National Railway. Those on the Mattawin range are equally contiguous to the Canadian Northern branch of the Canadian National Railway. The distance over either of these railways to Port Arthur or Fort William, will not exceed fifty miles in any case, most of it not more than 35 miles, with grades in favour of the traffic.

We are now prepared to estimate the cost of the ore,

delivered on cars at Port Arthur:

Cost of quarrying and concentrating as above, per ton	$2.39
Freight	.50
Handling	.10
Cost at Port Arthur	$2.99
Lake freight, 1920	1.10
Cost at Lower Lake Ports	$4.09
Value of non bessemer ore at lower lake ports, 1920	7.24
Profit on sale of concentrates, per ton	$3.15

Bituminous coal, when imported for coking, for use in iron furnaces, carries a duty of 53 cents per ton, with a rebate of 99%, making it practically free.

Limestone has to be imported from Kelley Island, in Lake Erie. The pre-war price for this material was $1.10 per ton, landed on the wharf at Port Arthur.

Before dealing with the market for the output of a steel industry, it is important to consider the favourable geographical position of Port Arthur for its distribution.

Approximately, midway in the transportation system of the continent, shipments can be made to all mid-continental points with a shorter rail haul than that of any competing works, with the added advantage of cheaper raw materials. Such a plant at Port Arthur would command the market for steel products for that immense territory reaching from the Great Lakes, to the Pacific Ocean.

During the season of navigation, and cheap water carriage, a Port Arthur industry could compete with Eastern steel concerns in certain products, as far east as Montreal, while to the west, three transcontinental railways tapping every portion of that immense territory, will bring a non-competitive market to its doors. That market will consist of:

Steel rails and track material. Between Port Arthur and the Pacific Coast, there are upwards of 10,000 miles of railway tracks, 5% of the rails of which have to be renewed each year, calling for 50,000 tons of rails, without taking into consideration the rails for new mileage of main line and sidings continually being built. Eastward, Port Arthur could compete for the supply of at least 30,000 tons of the requirements, which, with angle bars, track bolts, spikes, etc., would mean an annual market continually increasing, of 100,000 tons of track material.

Wire Rods, Fencing, etc. A non-competitive market in the West, to provide for the requirements of two hundred million acres of agricultural land, with hundreds of towns and villages.

Steel Plates Ships plates could be produced at a price that would permit the local Shipbuilding plant to compete with any similar plant on the Great Lakes, in shipbuilding, or repairing, and could supply the Pacific Coast plants in competition with the world.

Merchant bar iron, plates, nails, etc. A Port Arthur plant could command the market in Canada, from Lake Superior to the Pacific Coast.

These various items would provide a ready market for the output of a 1,000 ton steel plant at Port Arthur.

Port Arthur is well situated to take care of the output of by-product coke ovens.

Unlimited hydro-electric power is available, at around $20. per H. P. per year.

This memo has only dealt with some of the more accessible iron deposits, in addition to these there are immense tonnages of available ore on the Loon Lake (hematite) range, the Nepigon Atikokan and Steep Rock ranges, all of which are within economic distances from Port Arthur.

Coal Mining in Cape Breton.

The following account of the present conditions under which coal is mined in Cape Breton has been prepared by officials of the British Empire Steel Corporation, and gives the owners' side of the case. We have not, unfortunately, a similarly lucid and authoritative statement of the miners' side of the case for publication.

As conditions in the coal-fields from coast to coast are in essence similar, this account may serve as a foundation of fact upon which to build structures of agreement between operators and operatives in the various fields.—Ed.

The situation of the Dominion Coal Company must be considered under two heads, namely:

a. Temporary and world-wide trade conditions, arising out of the war.

b. Permanent and local conditions, inherent in the situation of the Company's collieries and markets.

Temporary and world-wide conditions which made it possible to pay the wages called for by the Montreal Agreement, and which now require a reduction in wages, are as follows:—

Conditions making high wage rates possible.

a. The rise in commodity prices (or decreased purchasing value of money) necessitating larger expenditures for goods of all kinds, when compared with pre-war prices.

This is usually referred to as "inflation" and it is necessarily accompanied by increased cost of living and higher rates of wages.

b. Higher selling prices for coal, the commodity which the Company produces and sells, and out of which it pays wages.

c. Decrease in the coal production of the World, due to army drafts, opening up the European market to Nova Scotia, at good prices, for the first time.

d. Heavy demand for steel goods, taking a large proportion of the Company's coal output for steel-making purposes.

e. Unusual demand for steamship's bunkers at Nova Scotian ports, and supplying of cargo coal to vessels calling at these ports.

Conditions now requiring reduction of wage rates.

a. The fall in commodity prices (or increased purchasing power of money) enabling the purchase of all classes of goods with smaller expenditures of money when compared with war-time prices.

This is the process of "deflation" and it is accompanied by decreased cost of living, requiring and permitting only lower rates of wages.

b. Constant lowering of the selling prices of coal, which, being a commodity, must follow the general trend.

c. Increase in the coal production of the World, caused by industrial restoration in Europe, closing this market to Nova Scotion coal, at our present cost of coal mining.

d. Entire lack of demand for steel goods, reducing greatly the proportion of coal used in steel making.

very difficult, and as not permitting competition with ports and entire cancellation of cargo business at these ports.

f. Increased pressure of United States competition in the whole of Eastern Canada, due to excess of coal supply over demand in the United States.

The permanent and local conditions in the coal industry in Nova Scotia have always been recognized as very difficult, and as not permitting competition with United States coal without protection by customs import duties, and the payment of a lower scale of wages than that of competitive coalfields in the United States.

This permanent limitation of the Nova Scotia field was recognized by the International Officers of the United Mine Workers in the negotiations which led to the extension of the organization into Nova Scotia, who assured the coal companies under date of February 21st 1919 that the desire of the miners of Nova Scotia to have the United Mine Workers of America extend its jurisdiction to Nova Scotia "does not arise from any intention to make the wage rates and working conditions of Nova Scotia conform to those obtaining in the other districts of the United Mine Workers of America." The coal companies were further given the assurance "that the limitations of Nova Scotia in regard to outside competition in the sale of coal are recognized by the incoming Mine Workers of America, and will always be borne in mind in the future.

This limitation of the competitive ability of the Nova Scotia coal industry consists in the ability of the coal operators of the United States to mine coal at a cost which is very much lower than is possible in Nova Scotia, said ability arising frkom more favourable physical conditions of mining. There is no method by which this superiority of the United States coal operator can be overcome, and Nova Scotia's disability in this respect must and has been generally recognized.

The pressure of American competition in coal was never more serious than at this time, because United States coal mines were never so highly developed for output as they are now.

In recent years, in addition to the temporary worldwide conditions of money inflation, previously referred to, the producer of coal in Nova Scotia has had the benefit of certain temporary conditions that have tended to increase the cost of imported coal, and to afford additional protection to Nova Scotia coal, over and above the usual Customs Duty, namely:—

High Freight Rates and Exchange Losses.

This additional protection has consisted of the following factors:

a. High freight rates to the U. S. border.

b. Premium on New York funds, ranging around 12 to 15 per cent, which has to be paid on the pitmouth price of the coal, plus the freight rate to the border.

c. Maximum wages paid to mineworkers in the United States.

All these conditions have undergone or are about to undergo drastic changes in a downward direction.

Since the middle of the Summer of 1921 exchange has dropped as low as 4½ per cent, and its tendency is certainly downwards on the long swing.

A reduction of ten per cent on farm product freights was announced in November by the railways of the United States.

A ten per cent decrease in freight rates on Canadian railroads was effective 1st December 1921. Further decreases in railway freights are confidently looked for before the Summer of 1922. The American Mining Congress, a very influential political body in the United States, has memorialised the U. S. Congress urging a 25 per cent reduction in freight rates for the relief of mineral products and the mining interests of the United States.

The Wholesale Coal Association of the United States has petitioned the Interstate Commerce Commission for a reduction of freight charges on coal, and for a restoration of the rates, charges and differential relationships existing in 1917.

Reductions in miners' wages have been general in the United States in non-union fields, and average at the end of October not less than 30 per cent. Outside the Central Competitive District miners' wages have returned to the standards of 1917, for the most part.

The slackness of bituminous coal demand in the United States is shown by the fact that the stocks of bituminous coal in the United States on November 1st 1921 are estimated by the United States Geological Survey at 47,400,000 net tons, sufficient for 43 days' requirements at the average rate of consumption. With the exception of the Autumn and Winter of 1918, records show that at no subsequent or previous time has there been such a large stock of coal on hand at this time of the year. Accompaning this unprecedented condition of large stocks of coal on hand, is an abnormally low rate of consumption.

Spot-mine prices range from $1.50 to $2.00 for run-of-mine coal.

A substantial reduction in the rate of mineworkers' wages is expected to follow the expiry of the current wage agreement with the United Mine Workers at the end of March, 1922.

The effect of this combination of factors upon the Montreal market will be to reduce the selling price of coal by from $1.50 to $2.00 per ton from the prices current in the Autumn of 1921. This reduction of selling price in Montreal will, of course, cause an identical loss of revenue at the pitmouth in Nova Scotia.

The lack of demand for coal and the Company's inability to sell coal in face of competition from the United States coalfields showed a steady decline in sales month by month during this year, a condition of affairs which is caused by heavy importations of coal from across the border, sold at a price the Dominion Coal Company cannot compete with because of high costs of production in its mines.

The Company's inability to make coal sales arises from inability to meet American prices, by reason of the high cost of production. The importation of United States coal into Canada during 1921 has been for the nine months ending September as follows. The steady decline in the selling price (or declared value at the border) is very noticeable.

Month of 1921	Bituminous Imports—Tons	Value in Dollars	Value per ton
January	1,637,364	7,578,075	$4.52
February	1,148,631	4,751,700	4.13
March	1,401,431	5,594,923	3.99
April	696,017	2,405,750	3.44
May	756,064	2,540,662	3.35
June	1,064,668	3,694,226	3.47
July	1,246,971	4,442,698	3.56
August	1,298,555	4,155,432	3.20
September	1,302,200	3,715,473	2.86
	10,551,901	$38,879,939	$3.72

A drop of $1.50 per ton in the selling price of coal during the first nine months of 1921 is indicated by these figures, but during the period from October 1st to date the drop has been still more severe. The selling prices of the Dominion Coal Company must conform to these lower levels, if sales are to be made.

For the first half of 1921 the import of American bituminous coal into Eastern Canada compares with two previous years as follows:—

Imports of U.S. Coal Maritime Prov. & Quebec during first half of:—	Short Tons.
1921	1,403,724
1920	782,774
1919	1,058,594

During the second half of the year coal has been imported into Quebec at a rate greater than during the first half of 1921, and sales of U. S. Coal have been made at ports in the Maritime Provinces, such as St. John, N.B., and Chatham, N.S., which were regarded as an unassailable market for Nova Scotia coal.

Increases in Wages.

Increases in wages during the period of rising prices asked by the workmen, and granted by the company, were as follows:—

Date of Increase	Increase over Previous rates.	Cumulative Increase over Rates of 1916.
1st June 1916	6%	6%
1st November 1916	15.9%	22.9%
1st May 1917	14.2	40.6%
1st January 1918	16.0%	63.1%
1st July 1918	5.1%	68.0%
January 1920	9.0%	96.2%
1st November 1920	12.5%	120.7%

Individual rate increases have exceeded the figures above given.

The average daily earnings of all classes of workmen at the Dominion Collieries have risen as follows:—

Year	Surfacemen	Underground	Mining Coal	Total Average
1914	1.87	2.07	3.06	2.46
1915	1.95	2.05	3.01	2.48
1916	2.06	2.17	3.30	2.64
1917	2.62	2.80	4.21	3.35
1918	3.32	3.64	5.39	4.25
1919	3.48	3.79	5.65	4.42
1920	4.00	4.41	6.55	5.02
Sept. 1921	4.47	5.00	7.22	5.73

These figures indicate increases over 1914 rates as follows:—

Surfacemen	140 percent
Underground Labor	145 "
Mining Coal	136 "

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

The actual individual annual earnings were greatly in excess of this amount.

The difficulty of the Company's position is apparent when it is stated that with an output reduced by 34 per cent and its productive employees reduced by 33 per cent (the figures being, of course, virtually the same) it has been necessary to carry on the payroll a force of non-productive employees whose numbers declined only by 6 per cent, and rate of wages was increased by over 140 per cent.

The effect of lower outputs, lessened individual productivity, (not miners at the face) and increases in the rate of wages has been to increase the labour cost of producing of a ton of coal since 1915 by approx. 200 per cent.

It has been possible to pay such additions to the payrolls only by passing along the cost to the consumer, but this is no longer possible.

The Selling Prices of Coal.

Coal has for months been out of line with the prices of other commodities. Most commodities, except coal and those such as iron and steel, which depend for their production cost on the cost of coal, have been deflated to about, and in some cases, below the pre-war level. The supply of coal is now hugely in excess of the demand both in the United States, Europe and in Canada, and prices are daily quoted lower. There is no known reason to expect that coal can stand out against the world-wide tendency to lower prices.

Already, and in the past six months, the Company has been compelled to accept lower prices for its coal, and the average selling price shows a steady decline month by month since the opening of the St. Lawrence navigation season. Lower prices than prevail today are now being quoted, and will be quoted next year, by the Company's competitors, and it will not be possible to sell the Company's product unless its price is materially lowered.

Wages form the largest item of the cost of production; hence a reduction in wages is required to enable the Company to hold its customers.

In regard to future sales the Company believes it can sell the entire product of its mines in Eastern Canada, provided it can offer customers coal at competing selling price.

In pre-war years, up to two million tons per season were sent up the St. Lawrence by the Company, a quantity which was approximately half the annual output and this market is still available if the hindrance of excessive cost of production can be overcome.

During 1922 there will still likely remain some of the additional protection to the Canadian coal producer occasioned by high railway freights and the premium on New York funds. Most, if not all of this, will probably have been removed in 1923 season by return to normalcy in the United States and restoration of Canadian currency to parity of exchange.

The year 1922 will, therefore, present an opportunity to regain the whole of the St. Lawrence market such as will not speedily recur, and, moreover, the St. Lawrence market offers the only outlet for coal that will enable the mines in Nova Scotia to operate, except on the most limited scale.

The Cost of Living.

The cost of living is not calculated by any official body in Canada. The Labour Gazette issues monthly a calculation which includes foodstuffs, rents, fuel and light, but omits clothing. The same is true of British statistics.

Index numbers are not an accurate index to the cost of living. The only accurate measure of changes in the cost of living is one based on changes in the retail cost of the various items of expenditure, weighted according to their relative importance in the family budget.

In August 1918, at the instance of the Fuel Controller, an enquiry was made into the cost of living in Pictou County, and a budget of living costs was agreed upon by a Committee representing the workmen, the Coal Companies, and the Department of Labor. This budget priced at the various dates mentioned below, shows the following variations, namely:—

1914 as	100% —	100%
January	1918 —	151%
August	1918 —	164%
August	1919 —	182%
August	1920 —	232%
August	1921 —	160%
December	1921 —	150%

Living costs in Pictou County at this date are, therefore, 50 per cent above those of 1914, or about what they were four years ago in January 1918.

A number of other authoritative calculations are available which relate to other parts of Canada and the United States, and for comparison with conditions at the Mines in Nova Scotia must be corrected to allow for the lower rent and fuel costs at the Mines. These outside calculations agree in putting the general cost of living (outside the local mining centres) at 60 per cent above 1914, a figure that agrees closely with these previously mentioned, when correction for low rental and fuel prices is made.

General Conclusions.

The ability of the Dominion Coal Company to pay wages depends upon its ability to sell coal.

Coal cannot be mined and sold at a profit at prices prevailing and likely to prevail in 1922, because of the following conditions:

Selling price of coal.

During 1922 the Company anticipates that coal prices will be less than the prices of the early Summer of 1921 by	30 per cent
and less than the prices obtainable when the Montreal Agreement was made by	50 per cent

Cost of Production.

By reason of higher wages, higher costs of mine supplies, increased taxation by federal and provincial governments and workmen's compensation, by reason of a lowering of output by 30 per cent, by disproportion of non-producers employed and smaller number of miners, reducing efficiency, the cost of producing coal has risen when compared with 1914, by	224 per cent

Earnings of the Mineworkers.

Earnings of the employees at the coal mines are from 120 to 200 per cent greater than the rates of 1914, and may be fairly averaged at an increase of. .	140 per cent

Expenses of the Individual.

The cost of living at the mines in Nova Scotia is between 50 and 60 per cent above the cost of 1914, and may be fairly averaged at	50 per cent

EDITORIAL

CANADA'S COAL

THE modern colliery is the embodiment of a closely-run commercial enterprise. Net profits per ton of coal sold are small. Labour is the chief item of cost. Administration and other overload charges are relatively and absolutely small. Payment of interest on capital investment and of reasonable dividends is necessary to the continuance of all industries. Coal must be marketed in the face of strong competition.

Strange as it may seem, coal miners do not grasp the fact that, when they stop producing, they are piling up liabilities against the colliery, and thereby automatically reducing the chance of bettering their own condition. Every dollar of debt loaded on the back of the mine by this, as well as by other means, must be paid back through the agency of coal brought up from the mine.

Trite and axiomatic this proposition may be; yet it has not yet been borne in on the consciousness of the coal miners, whose lot, by the same token, is rather to be envied than pitied.

It is pitiful, it is amazing, that in these days when the machinery of the law will give him the fairest of fair play (for there is always a preponderance of sympathy for the employee as compared with the employer), the miner should deliberately choose to impose suffering, loss and privation upon the whole community. He seems to think—or to believe that he thinks—that by dislocating trade, causing large losses directly and huge losses indirectly to his own fellows and to the country at large, he can advance his personal interests.

We regret that the coal iners of Alberta have joined hands with the strikers on the other side of the international boundary. We have in Canada adequate eans for adjucitating firly between te disputnts. As the general public is in any case both judge and gury in the long run, only loss to both rides (but principally to the miners) can result; the merits of the case rest as before. The only ones that can be jubilant at present are those parasites that depend for their livelhood upon their ability to arouse class hatred.

"LEST WE FORGET."

In the thich of the Passchendael fight, an Anglo-Canadian and a Canadian were discussing the merits of the Britisher. The converstion wound up with the remark, by the former, that the Englishman is the most merciful man in the world. It is true. The sight to be seen any day there was a "push" showed that it is true also of Canadians. When German prisoners were busy carrying in wounded on stretchers, they joined the long lines of Canadians waiting their turn at the coffee-stalls, and were treated without discrimination by soldiers, padres, and Y. M. C. A. workers.

There is a moral in this.

We Britishers are apt to forget, and to let by-gones be by-gones. This is, for the most part, an admirable characteristic, and bound to stand us in good stead in the long run. But, in the meantime, it may lead us into doing less than justice to our neighbors.

As in the war, so in the peace, Canadians are far removed from the scene of action. During the wartime we had plentiful reminders of what was going on in France and Flanders, and were inspired to do our bit. The French are still hard pressed, now by economic forces rather than by armed foes; in fact they still bear the brunt, as they did when under arms. We, suffering under no such economic pressure, are more than likely to forget their struggle, and to blame them unduly for their seeming laack of democratic spirit and Christian forbearance. It is easy for us to moralize.

We print today a little reminder of the difficulties under which the French iron miners are working today, as the result of deliberate and well-calculated destruction by the Germans. By a strange coincidence, we received, after this was ready for the press, a request from an eminent French metallurgist that we give publicity in Canada to a book he forwarded giving a full account of the German work of destruction. The French realize the British tendency; let us not forget to remain sympathetic allies.

ALLOY STEEL PLANTS FOR CANADA.

If Canada is to have a well-founded iron and steel industry, it must be upon the basis of some natural resource in which she is specially favoured, or perhaps pre-eminent. The coal of Nova Scotia, in conjunction with the iron-ore of Newfoundland, offers one such case. Elsewhere, the solution of the problem is not yet in sight.

Of all our natural resources applicable to metallurgy, hydro-electric current is at present the most highly developed. During the war-time full use was made of this energy to produce synthetic pig-iron and to make steel for shells. In the latter, Canada was pre-eminent. Now, with prices lowered, most of this equipment has of necessity fallen into disuse, and has in large part been dismantled.

There may, however, develop from the war-time ex-

perience something of permanent value to the country. It was during that period that the particular use and advantage of the basic electric furnace came to be recognized. The significance of this development is not yet fully or widely realized except by the few that have followed the matter closely.

One tendency of our times is to require "safety first." In engineering this means stronger bridges, sounder rails, tougher axles for motor cars, stronger wire ropes. To the iron metallurgist it means purer iron and steel, and alloy steel. Always the call will be for better and better quality, until even structural shapes for building, ship's plates, and the wheels of freight cars, will be alloy or other special steel or iron, and the weight or space saved will be worth the added cost.

This may give Canadian metallurgists their opportunity. We have not the means at present of producing the ordinary qualities of iron and steel in direct competition with producers on this continent or elsewhere. We have, pre-eminently, the special materials and the special energy required to convert this crude iron into finer forms.

Just before the "boom" broke, there was incorporated "Canadian Electric Steel, Limited," to take over and expand into a complete commercial plant equipment that had been used for making shells. It was intended (and we hope the plans will be consummated when markets return) to refine cheap iron and steel scrap in the basic electric furnace, and produce very pure, that is high-grade, steel, both plain and alloy. The determining factor is cheap electric current, and a good supply of cheap scrap is necessary. This plant may prove to be the pioneer in a Canadian industry of considerable dimensions.

The mooted alloy steel plant at Sarnia must have a different basis, as there is not available at that point the cheap electric current to produce economically the super-steel of the basic electric furnace. Probably the present metallurgical practice, using the open-hearth furnace as is the case across the border, is to be adopted, the Canadian protective tariff providing the added inducement. Such a plant has only a secondary interest or importance to Canada, as it will be dependent for its raw material upon imported iron or iron ore, and for its energy, upon imported coal.

"STAINLESS STEEL," AND OUR NICKEL INDUSTRY

The Britisher works best when he is "up against it." It required the discipline of a long series of reverses to make us really put our backs into the war effort. Now it has taken a stiff dose of hard times to make us tackle the peace problems with all our might.

Sheffield was unusually hard hit by the slump of a year ago. Always the home of inventive genius, she is once again helping herself along the road back to prosperity by finding something new that the world wants, and must have in spite of hard times.

Many a housewife has blessed the inventor of "stainless steel." Since the time it was invented and distributed throughout the world from Sheffield, there must have been a serious slump in the use of bath-brick, and a considerable saving in potatoes.

Last autumn there came word that Sheffield researchers have found the secret of "stainless iron" — a low-carbon stainless steel that is malleable, and can be rolled and forged. Its production was bound up with the problem of producing low-carbon ferro-chromium. When the unusual affinity of chromium for carbon was overcome in a process capable of industrial application, stainless iron became a factor in commerce.

Now comes word that Sheffield has produced another "stainless" metal, this time a non-ferrous alloy similar to nickel-silver, but with a smaller proportion of silver. Its comparative cheapness, resistance to corrosion, hardness, malleability and other desirable qualities give it a field that threatens to encroach seriously upon that of other alloys.

This is good news to Canadians. Canada produces the world's nickel, and the world's requirements are now so slim that the nickel industry is almost at a standstill. We wish the Sheffield scientists further success in their researches on nickel.

THE SURPLUS OF SHIPS

We have many things to remind us of the Great War. High prices, unemployment, burdensome taxation, maimed ex-soldiers — in fact, most of the troubles of the world today are laid to its charge. One of the most impressive of all these sights, though, is the mile after mile of ships laid up in the Hudson River, near Poughkeepsie. From across the river they look like toy fleets. In reality they are ocean-going freighters, ready and anxious to vindicate the high hopes of their builders on all the seven seas.

As an evidence of the magnitude of the war effort of the United States, the sight of this fleet could hardly be bettered. But their rusting sides turn one's thoughts inevitably in another direction, and the predominant feeling is one of dismay that such a huge lot of human effort, which should now in this time of stress be available for human use, is actually useless.

Nor is there any probability of a use being found for this huge fleet. Without them, the seas are overmanned with cargo boats; and the world's ports are congested with idle freighters. When international trade revives, it will be well-built boats, belonging to well organized companies, that will carry the cargoes. The boats of the United States Shipping Board will in all probability lie rusting in the Hudson until they are towed away to be broken up. They were made wholesale, in a hurry, and are not of a quality that can complete with the solid British bottoms that now once more carry most of the world's cargoes. When 1490 of the derelict boats were recently offered for sale, no serious bids were received. This one fact speaks volumes.

The future of the ship-building industry in Canada is a problem on which some at least of our leaders in business have clear ideas. The inclusion of the Halifax shipyards in the British Empire Steel Corporation was not merely an accommodation for the stock-holders in the Halifax concern. For a generation or more it has been urged that Nova Scotia has all the natural advantages required of a ship-building centre. Now she possesses the plant for building ships economically, and needs only the return to normal conditions, the scrapping of the hastily-built boats of wartime, and the training of her industrial population, to allow her to fulfil her destiny as a centre of maritime activity.

EDITORIAL NOTES.

The value to a steel producer of a diversified production is well illustrated by the fortunes of the Steel Company of Canada during this trying time. Though rails and large sections are in small demand, the housewife cannot get along without tacks, nor the farmer without fence-wire; and there are several million such consumers of steel products throughout the Dominion. Probably the iron and steel works in Cape Breton (the nearest thing we have to an indigenous Canadian iron industry), which is now on the verge of closing down for lack of orders, will have provided for fabricating more of their raw product before the next stretch of hard times comes upon us.

Another instance of the value of diversified production is the continued prosperity of by-product coke ovens throughout the period of depression. When the demand for coke has been seriously diminished, as at present, it may reverse its original role, and become the by-product, with gas, sulphate of ammonia, and tar and its products as the main issue.

W. Jett Lauck, one of the leaders of the United Mine Workers of America, is quoted as saying, "The United Mine Workers defy the country that wants deflation of wages!" Mr. Lauck seems to have the heart of a lion, and the confidence of a born leader. We wonder which battalion he headed in the great fight at Chateau Thierry.

The Port Arthur, Board of Trade have recently memorialised the Department of Mines, Ottawa, requesting that the unfinished magnetometric surveys of the iron ranges in that district be completed. This is both fitting and timely. For the sake of the slight amount of expense involved, we might well afford to learn more about these bodies of ore, of such immense potential value, and of special interest at present in view of the experiment at Babbitt, Minnesota.

SYMPOSIUM ON ELECTRIC CAST IRON.

At the Annual General Meeting of the American Electrochemical Society, to be held in Baltimore on the 27th, 28th and 29th of this month, there will be a symposium on Electric Cast Iron. This has been arranged under the charge of Messrs. Bradley Strongton and A. T. Hinckley, and bids fair to be of outstanding importance. The papers to be presented are as follows:

George K. Elliott: Cast Iron as produced in the Electric Furnace and some of its Problems.

R. C. Gosrow: A Comparison between the Shaft and Open Top Furnaces in the Manufacture of Pig Iron Electrically from Ore.

Robert Turnbull: Synthetic and Electric Pig Iron sanely considered.

Clyde E. Williams and C. E. Sims: A study of Carburization in the Manufacture of Synthetic Cast Iron.

W. E. Moore: Electric Cast Iron.

J. L. Cawthan: Operating Data Obtained in Electric Furnace Cast Iron Foundry.

H. M. Williams: Melting of Cast Iron in the Booth Rotating Electric Furnace.

W. E. Cahill: Electric Furnace Iron and Steel. Intermittent and Alternating Operations.

A principal interest of the American Electrochemical Society has always been ferrous metallurgy. An evidence of this is the plants to which excursions have been arranged for this occasion which are as follows:

Baltimore Copper Works.
Standard Oil Company.
Eastern Rolling Mill.
Baltimore Tube Co.
Howard Refractories Co.
American Refractories Co.
Bethlehem Steel Co. & Shipyard.
Fertilizer Plants.
Pennsylvania Water & Power Co.
Consolidated Gas & Electric Co.
Emerson Drug Co.

THE STRIKER.

(Press despatches announce that 600,000 coal miners will go on strike on April 1st. It is expected that 1,500,000 workers will be thrown out of employment.)

'Tis not enough that poverty and death
Stalk through the land. 'Tis not enough that war
Still hovers hateful in the West and East.
The STRIKER'S greed, his pride of power, his lust
For full dominion of our State and Realm,
These are insatiate. He must test his strength.
It matters not who suffer or who die,
He must impose his will upon the whole
Distracted body politic. Who cares
How many little children lack for bread?
How many homes destroyed, or broken hearts,
To blaze the progress of the glorious STRIKE?

* * *

Methinks that God reserves a special curse
For those inciting simple men to strike.

—ANON.

What One Iron Mine Means to Canada

By GEORGE S. COWIE,

Mines Dept., Algoma Steel Corporation.

No nation has made much progress industrially until it has mastered its iron and steel problem. Canada in the past decade has to a great extent improved its situation as regards its iron and steel products, but the supply of the base raw material (iron ore) entering into the production of iron and steel products has today fallen to the point where not a pound of iron ore is being mined at any point in Canada.

At the recent meeting of the Canadian Institute of Mining and Metallurgy at Ottawa, it was pointed out by the president of the institute, that the general public consider and believe that Canada is an agricultural country. Let us analyze this statement and see it if is a fact or only an often repeated statement generally believed, but not looked into.

On the eastern, or Atlantic side, of Canada we have the great Laurentian range of highland and mountainous country; on the western, or Pacific side, we have the Pacific range. These two great districts occupy over two thirds of the total surface of the entire country and as most of the mineral deposits are found in these ranges it should be sufficient to place mining in the forefront of Canadian industries in future. Let us make a summary of these facts and realize Canada's mineral resources in their true proportions.

Agricultural Area Limited

The total area of Canada is over three million square miles and of this area the ranges mentioned above occupy about 70 per cent. of which less than 3 per cent. is valley land or is suitable for cultivation, leaving 85 per cent. the only permanent industry of which is or will be mining in the future.

How does the mining industry affect our railways? Well, the latest available statistics show that in the United States the products of the mine total 50.95 per cent. the products of agriculture 11.20 per cent of the railway freight. In Canada the figures are, mine 35.40 per cent., agriculture 17.20 per cent. The mining industry furnishes the railways with more freight than any other industry and the fact that products of the mine furnish the most economical transportable tonnage, is one which shows the wisdom of encouraging the mining industry. Increased population may be said to be the solution of the railway problem, but we must remember that increased agricultural population can not fully solve this problem, for as pointed out, railways traverse a large mileage that cannot support an agricultural population so that we must look to our minerals to furnish tonnage. In our daily conservation we talk about our "unlimited natural resources," but our talk and actions belie our faith or belief in the extent of these resources. We should therefore keep before us the following facts:

1. That the value of our mineral production has increased year by year.

2. That during the past twenty years the per capita production of minerals has doubled.

3. That only 15 per cent. of this vast country is suitable for agriculture.

4. That only a small portion of the country has been intensively prospected. This fact should prompt us and give us courage to look to the mining industry with great confidence as the greatest and most important factor in the solution of our national railway problem.

In the Soo District.

The above facts and statements lead up to what mineral in our own district will give the railways the largest remunerative tonnage and to the city district the greatest revenue. We can say unhesitatingly that iron ore is that mineral which will accomplish the result and the purpose of this article is to present to the public the present situation and solicit their assistance in having the iron ore industry revived.

The Large Importations

We find that from 1912 to 1921 Canada imported iron ore as follows:

	Short Tons.
1912	2,019,165
1913	2,110,828
1914	1,324,326
1915	1,463,488
1916	1,964,598
1917	2,084,231
1918	2,145,592
1919	2,227,919
1920	1,632,011
1921	1,950,291

This is a yearly average of nearly 2,000,000 tons and assuming that this ore is worth $5.00 per ton we get a gross value of $10,000,000, to which we have to add the exchange which in the past few years has amounted to no small sum. These importations naturally have helped to turn the trade balances against us and the trade balances effect every one in the country whether he will it or not.

Why It Was Imported

Why was this large tonnage of iron ore imported, which necessitated such a drain on the country's finances? One reason is that the then merchantable mines were on the decline, finally vanishing, and low grade ores were not being treated in large enough tonnages at a marketable price to take their place. The known deposits of low grade ores only run from 32 to 38 per cent in iron and are high in sulphur and siliceous as compared with foreign ores running over 50 per cent. of iron and free from sulphur.

Development Worth While

The question is asked: Is it worth while developing these low grade ores? We say iron ore is the basic requirement of Canada and that not only our present demands should be produced from our own natural resources, but the industry should be well fostered and built up to many times its past proportions. No doubt there are those who are extremely cautions and think it not wise to compete with foreign industry founded on more natural conditions than ours. These same cautions persons objected when a bounty was given on pig iron made by Canadian furnaces. Did the industry collapse when the bounty was stopped? It certainly did not, but went ahead and grew to be one

of our greatest industries. It is true it was pap-fed for a period like any other infant, but now it is self-supporting. We claim the same results for the iron ore industry if it gets the proper assistance.

When the U. S. entered the war and they required their steel to make their own munitions of war, it was generally believed that the Canadian furnaces and smelters would be unable to take care of our own requirements. However the tonnage was produced in an ever increasing volume and one of the very companies built up by reason of the bounty given on pig iron supplied 55 per cent. of all the shell steel made into munitions by Canadian industry. Was the bounty on pig iron worth while? We think the answer is the record itself and justified the amount of bounty paid.

High Cost of Beneficiation

Now that the known merchantable iron ore bodies are exhausted, the next step naturally would be to undertake the problem of supplying to the furnaces Canadian ore from our known low grade deposits, thus opening up our natural resources. It has been proven after very costly experiments that our low grade ores can be successfully treated and made an ideal ore for blast furnace users, but the cost of treating, or beneficiation, is so great that foreign ores can be laid down cheaper, and for that reason the Magpie mine in the Michipicoten district and the Moose Mountain mine in the Sudbury district are both shut down with no prospects of reopening.

What Magpie Closing Meant

Now what does it mean to have a mine the size of the Magpie shut down? We find that during the years 1916 to 1920 almost $2,000,000 was spent for supplies. About $500,000 of this was spent in the Soo and the balance in old Ontario, Quebec and the United States. In addition $633,000, was paid for freight on the movement of the ore produced, $217,000 for freight charges on coal. Other items were sundry freight $140,000, duty $60,000, power $19,000, while wages amounted to $1,650,000, or a total for supplies, freight and labor of $5,000,000, an average of $1,000,000 per year. If the Magpie Mine were in operation this year see what relief it would have afforded to the unemployment prevailing not to take into account the benefit of the circulation of the $1,000,000.

Request for Government Aid

The Federal government at Ottawa and the Provincial government at Toronto are going to be asked to jointly bear the expense of the necessary temporary assistance asked for, this assistance to extend over a period of 15 years. Such assistance would have the almost immediate effect of developing ore properties in various parts of the country and especially in the Province of Ontario which possesses probably 80 per cent. of the known low grade ore deposits. Those seeking the assistance show their good faith and are content that such assistance should be payable only after the ore has been actually treated and ready for the market. Further, that private capital takes all the risk of success or failure, establishes the industry and produces its product before calling upon the governments for any payments.

Why should the request for assistance be granted?

1. Every dollar is spent for labor. There is no natural increase as on a farm. Every dollar is paid out to Canadian workmen.

2. The rapid development of natural resources is the only means of meeting the financial obligations of the war.

3. The nationalized railways must be made to pay their way. Mine products are the largest single source of railway traffic and iron ore produces a larger volume of this traffic than any other mine product.

4. Established raw material supply of any commodity is a vital national necessity.

5. Abundant deposits of low grade ores are accessible to existing railway lines.

6. The granting of assistance would involve a small annual outlay but the large returns and impetus to industrial activity would be immeasurable.

7. As no iron ore mines are now in operation the payments to mine owners during the first two years would be very small. The amount payable thereafter, depending as it does on iron ore actually mined and beneficiated, will simply be a measure of the growth of the industry; the larger the growth and expansion the larger will be the benefit to the country generally.

8. The retention in Canada of large amounts of money now being sent out for the purchase of foreign ores, and on the other hand the employment and investment of foreign capital to help the mines.

9. Expansion of the agricultural industry on lands tributary to the mining and smelting centres, larger markets for the farmer and increased consumption of manufactured articles.

10. Last, but not least, the production of Canadian iron ores will complete the national equipment for the production of iron and steel as wholly a Canadian product, with the exception of the coal used, place Canada in a position of greater independence and assure the blast furnace and steel works a home product which, at any future time of stress, will enable Canada to carry on, within the confines of her own country, the complete production of iron and steel, independent of the help of a foreign though friendly neighbor, who at any time may put an embargo on the export of high grade ores which would render our steel plants helpless and useless, causing shut downs and unemployment, which would be nothing short of a national disaster.

Objections to assistance or any special concessions will be made by those who will advance the argument that assistance means increased costs to the consumer of steel products. Such, however, is not the case, for those seeking the aid do not seek any protection in the form of a tariff but are willing to invest their capital and develop the industry, and the blast furnace operator may still purchase in the cheapest market, so that the Canadian product mined and treated under the proposed policy must compete and can be sold where it is as good or better and comparatively as cheap as can be obtained elsewhere.

Expenditure for Farm Products

During the five year period mentioned before, we find there was spent in the Soo for farm products for the Magpie Mine, the following amounts:

Vegetables and fruits	$ 38,000
Meats	152,000
Flour and feed	54,000
Butter and eggs	48,000
Total	$292,000

If the iron ore mines in the Michipicoten district were opened up on a large scale the amount of such purchases would be trebled.

Every year you find in the government estimates large sums for the direct benefit of the farming and other industries, but you do not see any amounts set aside to encourage or assist the iron ore industry. I think the government should very carefully consider this very important phase of mining and this year grant such assistance as is necessary to allow the mines to reopen.

PIG IRON AND FERRO-ALLOYS

February, 1922.

The Dominion Bureau of Statistics reports that a slight increase in the production of pig iron in Canada was noticed during February as compared with the output during the preceding month. A total of 33,572 long tons was made comprising 25,400 tons basic iron and 8,172 tons of foundry iron. Of the basic iron produced all but 51 tons was made for the further use of the firms reporting, but most of the foundry iron was made for sale, only 31 tons being retained for the use of the producing firms. In January a total of 9,047 tons of foundry iron was made for sale so that there was a slight decline in the production of this commodity during the month under review.

Ferro-alloys produced rose from 604 tons in January to 1,232 tons in the current month, the whole output as usual consisting of ferro-silicon of various grades.

There was no change in the number of furnaces active during the month, the four in blast at the beginning continuing active. These furnaces comprised two at Sydney, one at Sault Ste Marie, and one at Hamilton.

During the month a continued though slight improvement in the demand for iron and steel products was observed. In the United States the average daily output of pig iron in February increased more than 5,000 tons over the January record, and there was a net gain of 12 furnaces blown in. The production of pig iron in Canada usually parallels the United States record very closely. The output from Canadian furnaces each month amounts to about the amount of pig iron produced daily in the United States. A continued improvement in the Canadian output may, therefore, be expected.

STEEL INGOTS AND CASTINGS

The output of steel ingots and castings in Canada was 9,000 tons higher in February than in the preceding month, the total output amounting to 42,388 long tons, comprising 40,939 tons of ingots and 1,449 tons of direct steel castings. Almost the whole of the production of steel ingots was produced by the basic open-hearth process, there being only 4 tons of bessemer steel ingots produced during the month. Practically the entire production was made for further use by the producing firms. Of the direct steel castings made, 1,337 tons was made for sale, and 112 tons was used in further steel work by the makers.

A total of 545 tons of basic open-hearth steel castings was made, most of which was sold, only 73 tons being used by the producers. Bessemer castings amounted to 132 tons, practically all of which was made for direct sale.

Electric steel castings produced during the month totalled 772 tons, as compared with 856 tons in January, as in the preceding month practically the whole quantity was produced for direct sale.

There was little improvement in the steel markets of Canada, although inquiries were reported as more numerous. A very little shading in prices was occasionally noted, but the feeling seemed general that a slight increase in the price might have the effect of stiffening the market and of generally improving the tone. The slight advance in iron prices on American markets during the last week of the month was possibly due to similar causes. The market outlook seemed improved at the end of the month.

A MODERN FIRE BRICK PLANT

The Ironton Fire Brick Company of Ironton, Ohio, has just recently increased their capital, to enable them to make some extensive improvements at their plant at Ironton, Ohio, and also develop a large acreage of newly acquired fire clay land in Carter County, Kentucky, in the heart of the famous Olive Hill Fire Clay region.

The building of two new kilns, a new steam heated concrete drying floor and the complete rebuilding of their ground clay storage bins, elevators, etc., together with the installation of a measuring device which enables them to measure positively and accurately any desired mixture of clays, gives them a modern plant at Ironton.

They have 712 acres of clay land, which has been estimated to furnish enough clay to last 100 years, manufacturing at the rate of 100,000 brick per day.

The clay deposit is exceptionally fine—a recent analysis showing a fusion point of cone 33, (3254 deg. Fahrenheit,) and analyzing:

Silica	51.97
Alumina	45.07
Ferric Oxide	1.57
Lime	.60
Magnesia	.46
Alkalies	.61

Plans are now being laid for the erection of a modern brick plant at their mines in Kentucky, where a plant site has already been provided.

Mr. E. F. Myers is President and General Manager.

OBITUARY

Lewis T. Miller

It is with regret that we notice the death recently of Mr. Lewis T. Miller at Pottsville, Pa., in his thirtieth year. Previous to the war he was with the Colonial Steel Company at Colona, Pa., where he served in turn as inspector and assistant paymaster for four years. He then enlisted as a mechanician in the aviation section in September, 1917, and was in service 22 months until July, 1919, when he was commissioned pilot in the Reserve Corps. After returning from service he went with the Witherow Steel Company as district manager of its New York Office. He also served with the Hess Steel Corp., at Baltimore, Md., and then came to the International High Speed Steel Co. as general superintendent, succeeding Mr. Arthur D. Johnson, now with the Atlas Steel Company Canadian works at Welland, Ont. Since July, 1921, he has been connected with the National Steel Rolling Company at Schuylkill Haven, Pa., as general superintendent, as well as being interested in work for Hartmann, Duncan & Rogow, Inc.

Stainless Steel in Engineering*

By JAMES EDGAR

Chromium steel, or as it is more popularly called, stainless steel, will have many engineering applications in the near future. Where corroding influences occur it will supplant other alloy steels. For cold storage equipment, engine valves, anti-submarine apparatus, air compressor valves, pistons, pump rods, etc., it should be of very great value. It can be supplied in various grades, in the machinable condition, for instance, in the specially heat-treated condition, complying with the mechanical properties required for specific engineering purposes, and for press work it is produced within such limits of composition and treatment as to ensure a satisfactory malleable steel as required for articles manufactured from sheet steel, etc.

The writer had the pleasure recently of inspecting Messrs. Thos. Firth and Sons Ltd. Sheffield works, where stainless steel is made, and he was much impressed with the evidence of its great usefulness and the proofs of its non-corrosive properties. It is an alloy steel containing about 12 to 14 per cent. of chromium, and it may be hardened in air, oil or water, and tempered to various degrees of hardness required for the different purposes for which it is intended. An ordinary carbon steel is hardened from a temperature of 760 degrees to 780 degrees Cent. But with stainless steel the tmperature for effective hardening is higher, and it is recommended that temperatures between 950 degrees and 1,000 degrees Cent. be used. This is due to the fact that phase changes take place at a much higher temperature than in ordinary carbon steels.

In comparison with ordinary carbon steels, stainless steel resists scaling to a marked degree with increasing temperature. Tests performed up to 1,000 degrees Cent. on mild steel, alloy steels, tungsten steel and stainless steels has shown that the stainless steel scales much less readily than any of the others.

Very notable demonstrations were provided recently by tests in the power house of Messrs. Thos. Firth's works, Tinsley, where a Westinghouse turbo-generator set was opened up after being in regular use since August, 1916, and in which a number of blades of stainless steel were fitted. The turbine had a capacity of 2,000 kw., running at 3,000 r.p.m. This set was put down in August, 1916, and since that time was in regular use, the average load being 50 lb. per sq. the full output. The steam pressure is 200 lb. per sq. inch, and the steam temperature, with super-heat, averaged about 600 degrees Fahr. The experimental blades were fitted on June 11, 1920, and alongside the blades of stainless steel there were fitted, for comparison purposes, a number of blades of the standard type supplied by the makers of the turbine. These were of 5 per cent. nickel steel. The details of the experimental blades fitted are as follows: — In wheel No. 8, situated at the low pressure end of the turbine, were fitted 12 new blades: three of stainless steel highly polished, with three of stainless steel unpolished aongside them, while on the opposite side of the same wheel, three more of stainless steel unpolished, with three standard blades alongside. These blades are 7 in. long by $\frac{3}{4}$ in. wide, the diameter of the wheel being 4ft. $1\frac{1}{2}$ in.

In the velocity wheel, situated at the high pressure end of the turbine, were fitted 24 new blades: on one side of the wheel, 12 of stainless steel unpolished, and on the opposite side six of stainless steel unpolished, with three of stainless steel highly polished and three of the standard blades alongside.

The working conditions of the velocity wheel are typical of those with dry steam at a high temperature, and the conditions at wheel No. 8 are typical of very wet steam.

The work done by this generating set since the fitting of the new blades is represented by a run of 3471 hours, with the demand fluctuating. On opening up the turbine it was found that while the standard blades were corroded in the usual way, the stainless blades, both polished and unpolished, were practically unaffected. All of them retained their original smoothness and sharpness, while the mirror-like surface of the polished blades afforded indisputable evidence that the surface had not been affected in the slightest degree. The stainless steel contained 0.30 per cent. carbon and 13.4 per cent. chromium, whilst the nickel steel contained 0.19 per cent. carbon and 4 .71 per cent. nickel.

The mechanical properties of the two steels, as placed in the turbine, are given in the following table:—

	Nickel.	Stainless.
Yield point, tons per sq. in. . . .	25.2	44.1
Max. stress, tons per sq. in. . . .	34.7	54.5
Elongation, per cent.	32.0	20.0
Red. of area, per cent.	61.0	59.7
Brinell hardness number	149	255

The results of this experiment obviously prove that the introduction of stainless steel for use in turbine blades will be of great advantage. The results of another experiment are equally interesting. Messrs. British Thomson Houston Co. early in 1916, with the consent of one of their clients, had one wheel of a steam turbine bladed with five different kinds of material, the object being to find out which of these materials would best stand up against the action of the steam. The row of blades selected was situated in about the middle of the machine, where previously early indications of erosion and corrosion had occurred. The blading materials chosen were phosphor bronze, nickel bronze, brass, mild steel, and stainless steel (two of hardened and two hardened and tempered stainless blades were inserted). The machine was put into service in the autumn of 1916, and was opened up for examination for the first time in April, 1918. The inside of the machine was found to be perfectly clean, and all blading in a good condition. A certain amount of erosion was visible on all trial blades except those made of non-rusting steel; the machine had not been in service sufficiently long to see very clearly the preference of one material over another, except that the brass blades seemed to have suffered most. There were no marks whatever on the stainless steel, while the mild steel blade edges were very rough. Phosphor bronze and nickel bronze seem to have the same resisting quality to the action of the steam and moisture.

The machine was closed up and again put into service, and was opened up a second time in July, 1921, and the inspection confirmed the previous examination, i.e., that the stainless steel blades were in very good condition and absolutely unaffected, the edges

* From Industrial Australian and Mining Standard.

being as sharp as when put in, and there was apparently no difference between the hardened and unhardened samples. The phosphor bronze, nickel bronze and brass blades were all roughened at the entrance edge, and very little difference is to be noted between them. The mild steel blades were badly roughened, and the entrance edge was worn away nearly 1-16 in. As far as resistance properties are concerned, the stainless steel is very superior to any other blading material which has been tried so far.

Another interesting application of the stainless steel was made by Messrs. Firth in the form of a ram of a three-throw electrically-driven hydraulic pump, manufactured by Messrs. Davy Bros. Ltd., Sheffield. This pump worked at a pressure of 1800 lbs. per sq. in., and was installed in 1916. The other two rams were of the standard non-ferrous alloy usually employed by the makers of the pump. The pump ran continuously — night and day — until the termination of the war. The wear on the stainless ram was one-sixty-fourth of an inch on the diameter of the ram, while in the case of the non-ferrous rams it reached as high a figure as seven times this amount.

Such tests as these constitute definite trials under working conditions over long periods of service, and the performance of the steel under such trials justifies the fullest confidence in the extended use of this material to many of the purposes for which it is so obviously fitted.

Some Properties of Stainless Steel

Riveting of Stainless Steel. — This operation presents no difficulty. Stainless steel rivets in the 50-ton condition should be employed, and these should be hammered up cold. Owing to the high tensile strength of the material, there is not the capacity for plastic deformation which is to be found in dead mild-steel rivets. There is, however, sufficient ductility present to enable satisfactory riveting to be done, providing allowance is made for the difference in the properties of the material.

Co-efficient of Expansion. — Up to a temperature of 200 degrees Cent., stainless steel has an average co-efficient of expansion per one degree Cent. of 0.0000109, as compared with ordinary mild steel, which has a co-efficient of 0.0000125, copper 0.0000172, and brass, 0.0000187. As the temperature rises higher the rate of expansion is slightly increased, the average co-efficient up to a temperature of 400 degrees Cent. (752 degrees Fahr.) being 0.0000114.

Thermal Conductivity. — In the well-tempered condition (50 ton tensile) the thermal conductivity is 0.0445 c.g.s. units, and in the knife temper (100 tons tensile) condition, the value is about three-quarters of the above. In comparison with these figures it is interesting to note that the conductivity of practically pure iron is 0.146 c.g.s. units.

Electrical Conductivity. — The electrical specific resistance of stainless steel, in the well-tempered (50 tons tensile) condition is 50-55 michroms per centimetre, and in the knife temper (100 tons tensile) condition it is 65-70 michroms per centimetre.

Magnetic Permeability. — In the well-tempered (50 tons tensile) condition the permeability is somewhat similar to that of 0.9 per cent. carbon steel in the normalised condition. This fact renders the use of stainless steel for the purpose of electro magnets of no special value unless freedom from corrosion is of primary importance.

Specific Gravity. — The specific gravity of stainless steel differs little from that of ordinary structural steel. Experiments have given the following results:

	Hard.	Soft.
Stainless	7.7605	7.7715
Mild Carbon Steel	7.8803	7.8837

Temper Colours. — The temper colours produced at much lower temperatures are an analogous phenomenon to scaling. It is well known that when hardened tool steel is tempered, the originally bright surface goes through a series of colours. During this process of colour change, with increasing temperature, the skin of the steel is seriously affected when visible red heat is attained. Stainless steel responds in a very different manner, and up to temperature of 800 degrees Cent. the effect on the surface is confined only to the colour effect. The same temper colour obtained during tempering in the case of stainless steel corresponds to much higher temperatures than in the case of carbon steel.

STAINLESS NON-FERROUS ALLOYS

The commercial development of stainless steel and iron appears to be causing perturbation among firms (British) interested in non-ferrous metals and alloys, which are perforce beginning to recognize that the new material threatens to supersede copper, brass, nickel, and aluminum for a number of purposes. A good deal of research work has been carried out lately with the object of evolving a stainless non-ferrous alloys and is already bearing fruit in the shape of the introduction of improved forms of nickel-silver, containing a much larger percentage of nickel than ordinary nickel-silver, and being therefore harder, more durable, and of a color more nearly approaching that of silver. To assert that these metals are untarnishable and stainless may be to claim more than the facts justify, but they undoubtedly represent a distinct advance in that direction, and, in addition, the price should be about one-third less than that of stainless steel and iron. The additional percentage of nickel employed in these metals necessarily increases their cost, but as it gives extra strength it is possible to save expense by using sheets of thinner gauge than are supplied in nickel-silver.

Apart from the question of stainlessness the research has resulted in the production of a more homogeneous metal than formerly, and as this means greater ductility it will now be possible, for the first time, to make deep stampings and pressings from sheets of alloys with a high nickel content.

It is anticipated that the new metals will, to a considerable and increasing extent, supersede electro silverplate for spoons, forks, cruets, table holloware, wire, and numerous other purposes. The color may not be equal to that of silver, but restaurant-keepers and others whose table furniture gets rough treatment, and cost much money to keep in repair, may consider the appearance quite good enough for their purposes. The new metal certainly has solid advantages. Owing to its strength, goods made of it are not easily damaged, they carry no surface of silver liable to wear off, and can be repaired without necessitating the costly operation of replating. Spoons and forks made of these alloys can be produced at less than half the cost of such goods made of stainless steel or iron. —Iron Age.

Coal Statistics for Canada

for the twelve months ending December, 1921.

(Dominion Bureau of Statistics.

The output of coal from Canadian mines during the twelve months ending December, 1921, amounted to 15 million short tons valued at $74,273,000, or $4.97 a ton. This quantity was 80% of the amount mined during the preceding year, when the total output was 16.9 million tons. In 1919 a total of 13.9 million tons of coal raised so that although the output in 1921 was 12% lower than in the preceding year, it was more than a million tons in excess of the 1919 production. The highest monthly output recorded was for November when more than 1.5 million tons was mined; the lowest was in April, the total for the month being half a million tons less, or 941,000 tons.

Alberta held the premier position among the coal-producing provinces, with an output of 5.8 million tons. Nova Scotia followed closely with 5.7 million tons. The output of coal from the mines of British Columbia amounted to 2.8 million tons, while Saskatchewan mined 332,000 tons and New Brunswick 180,000 tons.

An analysis of the disposition of coal during the year shows that 58.2% was shipped; 22.1% went to railroads for locomotive consumption; 7.2% was used about the colliery for power purposes; 4.2% was sold for ships' bunkers; 3.2% was put on bank; 2.6% was put on the waste dump; 1.5% was supplied to employees for domestic consumption; 0.6% was used in the manufacture of coke at the collieries; 0.4% was used in making briquettes. Included in quantities referred to in the disposition was 541,820 tons, lifted from bank during the year.

While at time of writing, data regarding stocks on hand at the beginning and at the close of the year were incomplete, sufficient returns had been received to indicate that the amount of coal on bank at Canadian mines decreased to less than half the amount in stock at the beginning of the year.

The output of coal in Canada during each of the past three years has been compiled by kinds and provinces. For convenience of reference the output during 1920 has in each case been taken as 100 and the corresponding percentage or index number has been calculated for the other two years. These data are given in table 1.

In the period under review Canada exported nearly two milion tons of coal or a little more than 13% of the quantity actually mined. The amount exported was only 78% of the total shipped for foreign trade in 1920, and even fell slightly below the amount exported in 1919.

Reference to the table of exports herewith shows that more than 1.1 million tons of coal was exported through British Columbia ports during 1921. This was only one per cent. less than in the previous year. It is to be remembered that these data do not show the province of origin but only the port of exit to the United States, and as the bulk of coal exported from Alberta is shipped through the Customs ports of Fernie and Cranbrook, it will be understood that the total exported coal credited to British Columbia ports was not all mined within that province. In the final report on coal statistics, the quantities shipped for export trade from the mines of each province will be shown. A total of 728,000 tons was exported through Nova Scotia ports and about 72,000 tons through New Brunswick ports . Exports from the other provinces of Canada were negligible.

Central Canada has always been dependent upon the United States for a supply of coal and data showing importations of anthracite and bitimunous coal from that country are therefore of peculiar interest to a very large section of the manufacturing community of Canada. Importations from the United States declined during the latter part of 1921 although a plentiful supply was at all times available, and total importations for the year amounted to only 87% of the quantities imported in the previous year. The total imports of coal in 1921 were, however, more

TABLE 1. OUTPUT OF COAL FOR CANADA BY KINDS AND PROVINCES

Provinces	1919 Short Tons	1919 Index No.	1920 Short Tons	1920 Index No.	1921 Short Tons	1921 Index No.
Nova Scotia						
Bituminous	5,790,196	90.	6,437,156	100.	5,734,653	89.
New Brunswick						
Bituminous	166,377	97.	171,685	100.	180,358	105.
Saskatchewan						
Lignite	379,347	113.	335,222	100.	332,117	99.
Alberta						
Anthracite	85,579	67.	127,513	100.	96,964	76.
Bituminous	2,285,957	67.	3,419,147	100.	2,871,919	84.
Lignite	2,562,124	76.	3,361,105	100.	2,885,537	86.
Total	4,933,660	71.	6,907,765	100.	5,854,420	85.
British Columbia						
Bituminous	2,649,516	86.	3,095,011	100.	2,840,870	92.
TOTAL DOMINION						
Anthracite	85,579	67.	127,513	100.	96,964	76.
Bituminous	10,892,046	83.	13,122,999	100.	11,627,800	89.
Lignite	2,941,471	80.	3,696,327	100.	3,217,654	87.
Grand Total	13,919,096	82.	16,946,839	100.	14,942,418	88.

than one million tons higher tan in 1919. Imports of bituminous coal into the whole of Canada during 1921 amounted to 85% of the quantity imported in 1920, and in both the past two years the quantities imported have been considerably in excess of the quantities brought in during 1919. Imports of anthracite coal amounted to 93% of the quantity imported into Canada in 1920, when the tonnage was only slightly below the amount brought in during the preceding year. The total imports of coal into Canada during 1921 amounted to 18,102,620 short tons, of which 13,536,250 short tons was bituminous and the balance, 4,566,370 tons was anthracite.

Nova Scotia, New Brunswick and Prince Edward Island each imported more anthracite than in 1920, but Nova Scotia and Prince Edward Island brought in less bituminous coal in the preceding year. The quantity imported into New Brunswick was larger than usual but only amounted to 41,950 tons. The Provinee of Quebec received 77% of the amount of bituminous coal imported during 1921 or a total of 2,684,566 tons. During the first nine months of the year bituminous imports into Quebec were in excess of those recorded for the same period in 1920. Imports of anthracite into the same province amounted to 85% of the 1920 receipts. Central Ontario did not bring in as much bituminous coal as during 1920, the total imports amounting to slightly more than 8.7 million tons or 84% of the amount imported in 1920. The importations were nevertheless slightly in excess of the amount imported during 1919. Anthracite importations into Central Ontario amounted to 95% of the quantities brought in during 1920, or a total of slightly more than 2.8 million tons. There has not been any pronounced shortage of coal in Ontario, and supplies from the United States have been readily available throughout the year.

TABLE 2. EXPORTS OF CANADIAN COAL BY PROVINCES.

Provinces	Short Tons	Index No.	Short Tons	Index No.	Short Tons	Index No.
Nova Scotia	994,107	80.	1,245,673	100.	727,951	58.
New Brunswick	59,090	52.	113,050	100.	71,534	63.
P. E. Island			2	100.	2	100.
Quebec	929	68.	1,372	100.	85	6.
Ontario	5				10	
Manitoba	167	23.	721	100.	1,690	234.
Saskatchewan	389	12.	3,132	100.	2,633	84.
Alberta	1,022	33.	3,106	100.	843	27.
B. C. & Yukon	1,014,341	85.	1,191,167	100.	1,182,528	99.
TOTAL	2,070,050	81.	2,558,223	100.	1,987,276	78.

EMPLOYMENT IN IRON AND COAL TRADES.

The reopening of the railway car and other shops after the temporary shut downs registered at the end of the year caused employment to show a considerable increase. Returns were tabulated from 700 concerns employing a total working force of 100,294 persons as compared with 77,380 workers on December 31, the difference representing an increase of 29.6 per cent. In the railway car and automobile divisions of the industries practically 24,600 more persons were employed. Increases on a much smaller scale were reported in agricultural implements, iron and steel fabrication and foundry and machine shop products, while reductions continued to be registered in the crude, rolled and forged heating appliance, iron pipe and steel shipbuilding divisions. Quebec, the Prairie Provinces and Ontario showed the heaviest increases, but there was also a slight gain in activity in British Columbia. The losses at the end of December, 1920, and the recovery from these declines early in January, 1921, were both considerably less than those indicated for the corresponding period in the present winter. The index number for the fortnight under review was approximately twenty-five points lower than during the same fortnight in 1921.

Coal mining.—Further curtailment of operations was reported in this group, in which 86 concerns with pay-rolls which included 28,770 persons released from their staffs 893 miners. The larger share of this decline of 3 per cent occured in the coal-fields at Fernie, B.C., but the mines in Nova Scotia and Alberta were also less active. The tendency during the corresponding fortnight of last year had been downward, too, although the recessions reported at that time affected fewer people. Employment during 1921 continued to decline steadily until the middle of May. The movement from them until the beginning of December was constantly upward. The increases were not sufficiently large to restore employment to the level indicated at the beginning of last year, however, and for the period under review the index number stood about seven points lower than in the middle of January, 1921.—"Employment."

Iron Mines in the Briey Region, France, Damaged during German occupation, and their Reconstruction

Abstract of paper by A. Guillain (Paris), in Journal of the Iron and Steel Institute

At the time of the declaration of war by Germany, eighteen mines were in operation and a new one was being opened in the Briey field. In the Longwy field fifteen mines and three quarries were working. In 1913 the production of Briey was 15 million tons and that of Longwy three million tons. The mines gave employment to about 15,000 workmen, mostly Italians. The total population dependent upon the mining industry was about 40,000. These people were housed in workmen's colonies built by the mine owners.

The distance from Briey to Metz is 20 kilometres. The town of Briey and all the mines between Briey and the frontier were under the guns of Metz. Within a few days after the declaration of war the whole of the Briey region was effectively occupied by the Germans. In the course of brief fighting three mines were drowned out. Otherwise no further fighting occured in the mining region, and the Germans could work the mines at their leisure or destroy them.

The German government then proceeded to demolish completely or to transport to Germany all the steel plants. The majority of the blast-furnaces were preserved and shut down. Most of the mines were kept working, and the ore was sent to Germany until, the fortunes of war having changed, they were closed down, and most of the material and stocks carried off.

That the destruction of the iron mines was not completed, as it was in the case of the coal mines of the North, was due only to the fact that the precipitate retreat left them no time.

German Organization for Working the Mines

German organization began in October, 1914. The first care of the central administration established at Metz was to transport to Germany all stocks of iron ore from both fields. These amounted to 1,400,000 tons. Prisoners of war were drafted for work in the mines. They were harshly treated and badly fed.

During the first year, 1914-15, only a few mines were worked, the production amounting to about 1,000,000 tons. From other mines much surface and undergound equipment was carried off. From 1916 onwards, the working of the Briey mines was intensified, and some mines already partly stripped were re-equipped. In that year ten mines yielded about 2,600,000 tons. In 1917, the output reached 5,200,000 tons, but, owing to scarcity of labour, the tonnage in 1918 was only 4,400,000 tons.

Pillaging of the mines was continued. During the whole of the four years of war operation the output amounted to only 13,300,000 tons, although it had exceeded 18,000,000 tons per year before the war. Because the only object of the Germans was to intensify production, the mines were found to be in a deplorable condition when the French owners returned in November, 1918.

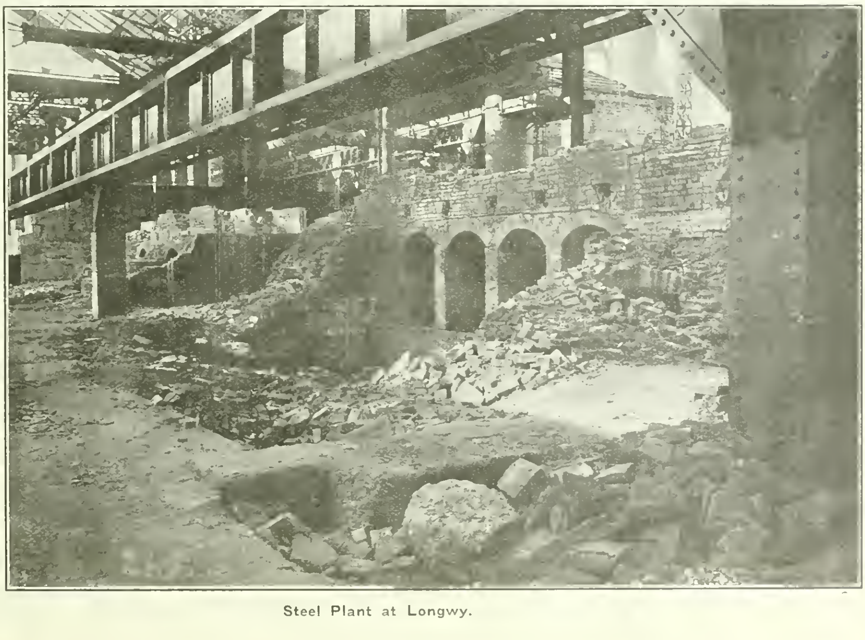
Estimation of Damages

The estimates of damages were made under the control of the Ministry of Mines of the State.

The sum total of the damage at the mines of Briey and Longwy, agreed on by the Ministry of Mines and the owners, amounted to 429,465,000 francs as direct loss and 120,000,000 francs as damages for reconstruction and loss of revenue throughout the period of resumption of work.

Results Achieved in Repairing the Mines

The work of repair was begun immediately after



Steel Plant at Longwy.

Shaft and Shaft-house Destroyed.

Rolling-Mill of the Longwy Steel-Plant.

the Armistice, under extraordinary difficulties. The orginal mine staffs were totally disorganized. The country was occupied by American troops until April, 1919, and the railway capacity was entirely absorbed by military transport. In spite of this the dwellings were gradually put in order and equipment and machinery repaired and replaced. All plans, drawings and correspondence had been removed or destroyed, and all haulage and transmission lines removed. To remedy this, the mining and smelting companies formed a joint purchasing association, which was, through another central body, commissioned to buy all necessary material.

Owing to the bad faith of the Germans, however, the sums necessary for reparation had to be advanced by the mining companies from loans contracted in France. Government assistance had been checked by want of cash, and the work of reparation to some extent stoped.

However, the actual expenditure of the companies on the mines, partly met by the French State, amounted at July 1st., 1921, to about 150 million francs. On account of the increase in cost of working and the extra pumping necessary, it is certain that the mines will never be completely indemnified. Moreover, the companies find themselves obliged to seek new workmen in France and particularly in Italy, and to train these afresh.

Nevertheless, within a year of the recovery of the mines by their owners, about 5,000 workmen had been recruited as compared with 15,000 before the war. At the end of 1920 the workmen numbered about one-half the pre-war establishment, and the houses were by this time almost entirely rebuilt or repaired.

Progress made is indicated by the fact that the output for December, 1918, was nil; for January, 1919, 14,000 tons; and for January, 1921, 500,000 tons. This is slightly greater than one-third of the pre-war tonnage.

This tonnage has been mined and marketed in spite of the destruction of plants, dispersal of labour and the cessation of all relations with clients for four years. Amongst other new trade developments, without doubt important quantities of ore will be exported to England.

The following is of historic interest. It is an exact translation of an official German document found at the Andery mine after the German retreat:—

TRANSLATION OF A GERMAN DOCUMENT

July 4, 1917.

Destruction of the Anderny Mine in case of a break-through on the front.

To the Imperial Administrator of Mines, Homécourt. Division A.

Attached hereto we submit to you a statement showing the time and number of workmen necessary for the destruction of the mine of Andery in case of a break-through on the front.

Directorate of the Andern Mine
(Sined) Joesten

SECRET.

Andern Mine, July 4, 1917

Statement of the work necessary for the destruction of the mine of Andrey in the case of a break-through on the front, and the wagons required for the removal of the more important material.

1.—Destruction requiring three-quarters of a year to make good.

Removal of pumps.

Blocking of shafts Nos. 1 and 2 by throwing in the cages and tubs after cutting the cables.

Destruction of the pulleys and the winding engines.

2.—Destruction requiring one and one-half years to make good.

As above.

In addition, to blow up the whole winding plant, engine house, foundations of the winding engine, and the stock bins.

3.—Permanent destruction.

As in No. 2. In addition, destruction by dynamite of the shaft lining. To blow up completely the head-gear, stock-bins, to burn the wood tower at shaft No. 2.

For the first case 10 men are required, time 24 hours.

For the second case 20 men are required, time 36 hours

For the third case 32 men are required, time 60 hours.

Twenty-five wagons will be required for the transport of the material, without counting those which would be necessary to remove the coal and ore, of which the quantity will be fixed according to the demands.

Andern Mine. Director (Sgd.) Joesten

STEEL AND IRON IN SCOTLAND.

The year 1921 was a disastrous one for the steel trade in Scotland as it was in America. It is perhaps not generally realized that Scotland is the largest producer of steel of any district of the British Isles. The ingot output of Scotland last year was 2,077,000 long tons. The next in order was the North-East Coast of England with 1,958,000 tons, with South Wales and Sheffield following. Scotland has, however, specially cultivated the trade for high-class Siemens steel such as is required for boiler-making, ship-building, bridge-building, and general engineering purposes. The Continent, on the other hand, has continued to produce the Bessemer quality of steel. The demand for war material and the necessity for great extensions have enabled the industry to greatly increase its power of production. There are many plants in Scotland to-day that embody all the latest developments, and can compare favourably with any steel plants in the world, although they are not on the gigantic scale of some to be found in the United States and the Continent. The prosperity of the country largely depends upon the steel trade being maintained at the highest standard in all respects, for upon this industry in Scotland and England rests the country's position as the greatest ship-owning and ship-building nation, as engineers in the building of railways and bridges in this and many other countries, and in production of machinery.

The year commenced with falling prices and increased foreign competition through falling exchanges. In March the coal strike upset all the calculations of the makers, and plant after plant was closed down as stocks of coal became exhausted and orders, which might have been secured for the West of Scotland, were picked up by continental makers. In August, when the strike was well over and coal supplies again available, prices were reduced, boiler plates to £19, ship plates to £14, and sections to £13 10s. per long ton. This action so reduced the difference between Continental and British prices, and Continental makers were so booked up with orders, that a more hopeful feeling prevailed until at a meeting of the Scottish and English Steel Association, it was found impossible to agree to uniform basis of prices for the two districts. Since that time Scottish producers have been competing with English in the other's territories, and with each other, and some very low quotations have been made. In the export trade, competition from the Continent has been much less severe during the last three months. — Commercial Intelligence Journal.

Making the Labor Union Responsible for Production

(Abstract specially prepared for Iron and Steel.)

In the March 18th number of "The Industrial Digest", Mr. T. M. Ave-Lallemant discusses very lucidly the question of the relation between employers and trade unions. The issue of collective bargaining, he states, must be settled on the basis of principles acceptable to society generally.

In their attitude towards unions, employers have the choice of four alternatives. They may discourage the unions, and, if possible, destroy them; they may disregard them; they may deal with them as they are; they may co-operate with them to bring about needed reforms.

Even if, as in England, labor unions were recognized, legaly constituted bodies, their position would still be dubious. American employers do not recognize the working men's right to bargain collectively. Labour is still regarded as a commodity. To many employers the so-called "open-shop movment" aims not only at a refusal to deal with labour organizations, but also at purely individual bargains. Other employers the so-called "open-shop movement" aims through shop committees or works councils.

But destruction of the union has not been achieved. It probably never will. So long as they remain they cannot be successfully disregarded. Their participation in wage settlements is, therefoe, essential to industrial peace and economical production.

The Open Shop Issue

Dropping all cant, let us see what the open or closed-shop issue really amounts to. Employers say that the unions, by insisting upon a "closed" shop, limit the freedom of workers as well as of employers to make such contracts as they please to make. The answer is that collective agreements **necessarily** limit freedom of contract; for the collective agreement stipulates that indivdual contracts made thereafter shall conform to certain terms defined in the agreement. If the agreement provides that the employer shall pay not less than the union scale of wages, then the "open shop" can mean only one of two things:— Either that the employer has no dealings with the unions, though some of his employees may be union men; or, that the employer makes an agreement with the union that does not bind him to apply given terms to all employees of a certain trade, but leaves him free to employ as many workers as he sees fit to whom the terms of the agreement shall not apply.

But a trade agreement that does not apply to non-union and union workers alike is of no value to the union or to its members. The union contends that since all benefit by its agreements, all should bear its burdens by becoming members.

"Soldiering" a Common Practice

The second major objection to the union, the charge that they instruct their members to limit their individual outputs, is made even by those employers that deal with them. The charge cannot be denied; but we have no present means of knowing how generally such restriction is practiced. Only better economic organization will do away with this custom.

Most trade agreements are, in the main, wage settlements, and do not generally fix definite standards as to the quantity and quality of work to be done. It is still left to the employer or to his foreman to get as much and as good work as he can out of the men. It is a question open to debate who has done more to break down the standards of quality in workmanship—the careless and poorly trained workmen, or the manufacturers of the "just as good" product.

If an agreement stipulates a time-wage, the faster workman has no inducement o do better than the average, the manufacturer's income is reduced, and the unions themselves are reacted against. Employers, therefore, have demanded agreements that stipulate payment by results. But the piece-rate system is the crudest of all methods of paymnt by results. It cannot fix either quantity or quality. It is unsatisfactory to both unions and employers.

The Real Solution

The step now holding real promise of progress toward a peaceful settlement, is the collective labour contract. This does not mean a trade agreement. Trade agreements are not enforceable contracts. They merely imply as many individual contracts as there are workmen employed. The collective contract is an enforceable contract between an employer nd a group of workmen who undertake to produce a quantity of a finished product within a certain time and for a fixed amount of money. The price to be paid for a given quantity of work within a fixed period is agreed upon. Results only are paid for, and there is no motive to limit production.

This has been done in a sufficient number of instances and on a sufficient scale to prove that the plan is practicable.

THE BASIC INDUSTRIES.

There is now substantial evidence that the basic industries are, in the United States, on the up-grade. The United States Steel Corporation is now operating at 60 per cent. of normal capacity, which is about twice what it was last year. Agencies in Canada representing American steel producers report a satisfactory increase in the volume of orders.

In Nova Scotia, orders from abroad for iron ore brighten a prospect that is otherwise dull. The labour disputes prevent the resumption of coal mining on a large scale.

It cannot be said that Canadian steel fabricating plants have a cheerful outlook just at present; but the tide is on the turn, and when the banks feel at liberty to release funds, there will be enough business in construction work and in providing equipment to make our steel men smile once more.

REMARKABLE COAL SEAM IN QUEENSLAND

Australia is the happy possessor of many fine coal fields, the principal area in New South Wales having a known area of 200 square miles with varying thicknesses up to 27 feet of the very best coal. In Queensland recently a seam, probably the thickest in the world, was proved to have a thickness of at least 93 feet. The coal is remarkable free from ash, and the vast seam is pure coal, devoid of any clay bands. The coal varies from 200 feet below the surface to 83 feet only, and at this latter depth, to decrease the cost of mining, it is proposed to use the open-cut system It is stated that on reasonable borings there are 450,000 million tons of coal proved.—Commercial Intelligence Journal.

THE VALUE OF BY-PRODUCT COKING A DEMONSTRATION

It was shown conclusively in 1921, according to the United States Geological Survey, Department of the Interior, that by-product coking of bituminous coal is continuing to supersede beehive coking. This change in practice has been in progress for some years, but the first convincing demonstration that the by-product branch of the coking industry could maintain itself in a period of industrial depression more strongly than the beehive branch was made in 1921.

In 1921 the output of by-product coke was almost 20,000,000 tons, and that of beehive coke was about 5,500,000 tons, figures that show a striking contrast to those for 1920, when the output of by-product coke was more than 30,000,000 tons and that of beehive coke was more than 20,000,000 tons.

The output of beehive coke in 1921 was less than that in any other year since 1885. One month of the year showed an output of only one-ninth the average monthly output in 1920. The monthly average for 1921 was only about 27 per cent of that for 1920.

The output of by-product coke in 1921 also showed a marked decline from that of 1920, though the output in the minimum month was more than half of that in the average month of the preceding year, and the output for the entire year was practically two-thirds that in 1920. This comparison of 1921 with 1920 becomes still more striking if we remember that 1920 was easily the "banner" year in the production of by-product coke in the United States. In other words, despite the extraordinary slump in business, which greatly lowered the output of by-product coke, it was greater in 1921 than in any preceding year except 1917, 1918, 1919, and 1920.

The continuance of the activity in by-product coking during a period when business was subnormal may have been due in part to the economic superiority to the by-product ovens over the beehive ovens, but it is in part due to the fact that many by-product coke-oven plants require elaborate organization and represent large investments and must therefore be kept active in order to preserve the working force intact and prevent the undue deterioration of the plants. The loss due to the operation of such plants at less than a normal profit is smaller than that which would be incurred if they were allowed to remain idle and thus to make immense investments wholly unproductive. Furthermore, the gas produced at many by-product coke-oven plants is sold under contract to public-utility companies that supply gas to near-by communities, so that the discontinuance of the operation of the by-product plant would constitute a violation of its contract with the public-utility company. In view of these facts the greater production reported by the by-product coke industry in 1921 can not be considered a measure of the relative cost of production in beehive and by-product ovens.

The Standard Steel Construction Co. Limited of Welland, Ontario, have received the contract for the structural steel work of the new mill building being put up at Schumacher by the McIntyre-Porcupine Mines Co., Ltd. The work on this building will be proceeded with at once and will make quite an addition to the already extensive plant at this Company's mines.

The Electric Furnace Company has moved its general and sales offices from Alliance, Ohio, to Salem, Ohio. By this action all departments of the Company will be consolidated at its works, Wilson Street and Pennsylvania Railroad, Salem, Ohio.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

Geology and the Foundry

Science is one, and indivisible. Light on this fact is thrown by the following, from the Foundry Trade Journal.

It does not appear to be generally known that there is a very close association between the foundry and the twin studies of geology and mineralogy, and whilst we do not suggest that this subject should form part of the curriculum of the apprentice moulder, we do insist that every manager should be acquainted with its rudiments.

Basically, the analogy is very strong, for rocks admit of a rough classification into igneous, or those which have been formed by the action of fire, and aqueous, which relates to those deposited by the action of water. In the foundry the metals and their slags can be regarded as artificial igneous rocks, whilst some of the slag-making materials and refractories are actually derivatives of aqueous formations. There is still another variety of rock, called metamorphic; these are aqueous rocks, which, through volcanic or other action, have been burnt or changed. Here again there is a similar action in the foundry when the molten metal comes into contact with the sand mould. Whilst these and similar analogies do not entirely help the foundrymen to make better castings at a lower cost, the study of geology and mineralogy will often disclose new and helpful view-points. He no longer looks on sand as such, but as silica, containing more or less clay, which latter is regarded as silicate of alumina. Slags often reesemble very closely the rocks, not only in appearance, but also in composition, and it is in their manipulation that the young metallurgist of the "tame chemist" variety not only forgets his geology, but often his simple chemistry and elementary arithmetic.

On one occasion we remember a young chemist vainly struggling with a basic slag, which was required to be quite thick, or, in other words, to contain 60 per cent. of lime. This he knew. Additionally, he was aware of the amount of lime that had been added to form the slag, and finally he was *au fait* with the chemistry of the process. He was carrying out the process fairly correctly, except that he was ignoring the influence of time. On being asked what he thought the lime content was in the slag he correctly estimated it to be 40 per cent., yet on his own showing he was making additions exactly equal to 2 per cent. By the time he would have made his ten additions to give the required 20 per cent., he would probably require another 10 per cent., as during this period some thinning actions were working against him. Now to such a man, unless he receives training under a superintendent who will make him apply his knowledge, his knowledge of geology and mineralogy will simply make him a nuisance in any manufacturng concern, except as a routine chemist.

Some of the refractory manufacturers are studying intensively mineralogy, and are members of a technical society especially formed to deal with their products. In this work, many steel metallurgists and a few associated with foundries take part. Whilst the steel manufacturer has to cope with higher temperatures, the foundryman has to deal with quantity so far as sand is concerned, and he is still striving for a freely venting, highly refractory sand suitable for all classes of work, which can be used over and over again. Obviously, any foundryman with a knowledge of metallurgy or geology can say definitely that no sand, as we know it, will ever bring this about.

Some of the benefits to foundrymen which have come directly to our knowledge go to show that many practical advantages can accrue. In one case in the Alps a newly-appointed French foundry manager discovered, through his geological training, a large deposit of suitable sand in the bed of the Rhone, which ran alongside the works, that satisfactorily replaced material previously brought from Belgium and Paris.

Kieselguhr (diatomaceous earth) was brought to the notice of another foundryman during his geological studies, and is of use for roughly annealing castings, since it is so light that practically non-moving air surrounds the object covered, and prolongs enormously its rate of cooling. The efficiency of furnaces can be considerably improved by placing kieselguhr between the metallic containing plates and the refractory bricks. Kaolin, or china-clay, is the purest of clays, and also the most refractory. These points are emphasised so strongly in geological lectures that when experimenting the foundryman geologist could never regard it as other than one of his most useful refractories.

LIGNITE BRIQUETTING IN U. S.

Lignite, or "brown coal" which contitutes approximately one third of the coal resources of the American continent, can be converted by carbonization in to a high grade fuel adapted to a wide range of purposes and limited only by its relative costs, according to a statement issued by Director H. Foster Bain if the United States Bureau of Mines. It cannot, however, be classed as a cheap fuel in the sense of competing with a high class, easily mined bituminous coal.

During the past summer, the United States Bureau of Mines has co-operated with the University of North Dakota in the operation of a lignite carbonizing plant, and more than a thousand tons of raw lignite have been treated and more than 400 tons of lignite char briquettes were produced, this being probably the largest amount of lignite char briquettes that has ever been made at one time.

By removing the moisture and a considerable portion of the volatile matter from the raw lignite, a char can be obtained which possesses a heating value and chemical analysis quite similar to anthracite coal. In this process, a ton of raw lignite will yield forty per cent of high grade lignite char. The physical form of this char is such that approximately one-third of it will go through a one-eighth inch screen, the remainder up to pieces the size of shelled corn. By the addition of eight to ten per cent of suitable binding material, excellent briquettes can be made, whose heating value and availability for general use is little less than that of Pennsylvania anthracite.

The fixed carbon in these briquettes may run from 72 to81 per cent, as compared with that of 35 per cent in raw lignite. This makes it practicable to transport the fuel to much greater distances than would be practicable with raw lignite. The briquettes are pillow-shaped, weighing about two and a half ounces each. When produced with suitable skill, the briquettes will stand handling, transportation and weather conditions in storage. The product is a stable one, thus removing the greatest limitation to the usefulness of the original lignite.

-:- EDITORIAL -:-

"MODERATES" IN CONTROL

In these dark days of industrial depression and labour disputes, it is encouraging to find that throughout the British Empire leaders of "moderate" tendency have regained control. This augurs well, not only for the solidarity of the Empire, but for the progress and industrial well-being of its component parts.

The first of the series of struggles came in the Motherland. The series of concessions wrung by the coal miners from the mine owners and from the public during the critical war years culminated in the demand for nationalization of the mines. The public judged the case, refused the labour leaders their immoderate and radical demands, and secured to the miners a high rate of pay in return for a good day's work.

In South Africa, where the strikers on the Rand resorted to force, the conclusion has been summary and decided, as befits military action. That a revolution, brought about by armed force, was intended by the agitators that precipitated the trouble, is attested by the official statement issued after the rebels had been dispersed. "People of all political convictions came forward to help the Government to put down what there is no doubt to have been a social revolution by Bolshevists, International Socialists and Communists." That the miners have returned to work pending an investigation of their grievances, speaks well for moderation of a large majority amongst them. That the burghers turned out almost "en masse" in support of their Government, demonstrates their appreciation of settled rule and the ideals of British justice. Premier Smuts has promised the miners that in spite of the revolution engineered in their name, their complaints will be considered impartially by the commission of enquiry now to be instituted. His word is his bond.

For years the political struggle in Australian has been between labourites of moderate views and those with a radical tendency. In New South Wales the latter have until lately been in control. Some attribute to this the fact that the productiveness of labour in New South Wales has lately fallen to such a low mark that industry there is now virtually paralyzed. New South Wales is blessed with many natural advantages; but these will be useless until the unnatural disadvantage due to the artificial restriction of output is removed. That the late Government under Premier Dooley is partly responsible for this state of affairs is demonstrated by the fact that he offered what was virtually a wholesale bribe to railway employees in his pre-election promises regarding wages and hours of labour. Happily, his regime is ended, and New South Wales may look for a return to prosperity under a leader whose principles are more in accord with true British tradition.

The recent attempt to traduce the morality of Nova Scotian miners has been an utter failure. That the living conditions in the colliery villages are far from ideal, is an undoubted fact, and the public should know more about these conditions, in order that they may judge fairly the miners' demands. That the miners have now unequivocally refused to accede to Organizer MacLachlan's "sabotage" advice, should give them a place in the regard of the public that will ensure fair treatment at the hands of their employers.

We print today a letter from Mr. Robert Baxter, once again the recognized leader of all the Nova Scotian mine workers. The moderation expressed in this letter, and the justice and frankness of the views he states, command the respect of the public. We wish that more of our labour leaders were like Mr. Baxter.

IRON AND STEEL IN INDIA AND THE EMPIRE

India bids fair to outstrip soon in her production of iron and steel, all the British Dominions, and to become an important factor in world production. This has long been predicted by students of the world's resources of iron-ore and coal. It remained for a Bombay banker, Sir Jamshedpur Tata, with the co-operation of an American technical staff, to begin to fulfil this prediction.

In 1912 the first of a series of modern blast furnaces was put in operation at Jamshedpur in the province of Bengal, as well as a complete steel works. During the war time this works supplied all the Eastern theatres of war with the railroad iron upon which military operations essentially depended. The timely enterprise of the Bombay banker may be said to have saved the East for Britain. Since 1912 the plant has been increased to include three blast-furnaces, and two more are in course of erection. A second company, the Bengal Iron Company, are also producing iron and ferro-manganese, and a third, the Indian Iron and Steel Company, is expected to begin production this year.

How do the British Dominions stand in comparison with India as iron producers? Canada at present leads; but unless radical changes are made in her methods of production, such as will take further advantage of her national resources, she cannot long maintain the lead.

The Nova Scotian industry has an abundance of ore and of coal; but the ore is rather low-grade and highly silicious, and the coal is in submarine strata, and so cannot be won so cheaply as the coal of some competitors in the iron and steel trade. The iron production of Central Canada is dependent for its existence upon imported ore and coal, and upon a protective tariff, and so cannot be considered seriously in world affairs.

South Africa, like India, has been considered a potential factor in the world's markets for iron and steel. Here, though, the development is still embryonic. There are good coking coal and good iron ore, both in abundance, as well as native labour. But the country offers only a very limited home market and is not yet well-developed by railway facilities, and a large export trade is not yet feasible. Nevertheless the pioneer furnace has been built, and we can logically hope that the Newcastle Iron and Steel Company will have a long and prosperous career.

Australia, like India and South Africa, is well provided with both coal and iron ore, in reasonably close proximity. In this case both are close to the coast, so the iron and steel plant at Newcastle, New South Wales, has the additional advantage of being located at a seaport. The plant is notable as representing the re-investment of earnings by the Broken Hill Proprietary company at their silver-lead-zinc mines in the interior. Unfortunately, perverse human nature has brought about a temporary (we hope) cessation of the operation of the plant. The wages of labour in Queensland are so high, and the productiveness of labour is so small, that even under the highly favourable natural conditions that exist at Newcastle and under protection of a high tariff, native iron and steel cannot compete with imported materials.

New Zealand is not so fortunate in her natural resources for iron making as is her big neighbor. Her main resource of iron is the long beach composed of titaniferous iron sand at Taranaki. A number of attempts have been made to smelt this ore economically, but none of them have been successful.

Meantime Britain holds her own in the production of iron and steel. Her iron ores are neither so high-grade nor so cheaply won as formerly; but scientific research is adding constantly to the material available. Her iron-stone strata, with failing content of iron, are now used for their content of potash, which increases in amount as the iron decreases, and is recovered as a by-product. British workmen are now once more settling down to work in earnest after the disturbances of the war years; and even India, with her high-grade ore, good coal, and cheap labour, will not for many a long year cut seriously into the British iron and steel trade.

NEON IN EVERY-DAY LIFE

It has often been stated, and almost as often disbelieved, that pure science is at the bottom of most of our present-day material progress. It is, ordinarily, hard to conceive how the abstractions of physics and chemistry, astronomy and zoölogy, can be applied to every-day human affairs. We have seen recently a perfect demonstration of the seemingly impossible.

Who would believe that the rare gas, neon has a practical use in operating an automobile? It is inert, incombustible, difficult to isolate, and until lately has been regarded mainly as a scientific curiosity. For a decade or more it has been used experimentally as a source of light; but research has only lately made it undoubtedly useful.

The manufacturers of electric lamps are among the most progressive of all modern men of business, though they are among the latest arrivals in the industrial world. Each of the huge plants throughout this continent has a research department, where highly-trained physicts and chemists search out Natures secrets. At one of these plants, in Pittsburgh, a young physicist was examining the properties of neon. He was impressed with the readiness with which a glass tube containing the gas glows when brought near a wire connected to an induction-coil.

In Pittsburgh everybody has an auto, and everybody is, likewise, bothered at times with ignition troubles. After the day's work comes a spin, and occasionally a stalled car. Our physicist naturally joined together the two parts of his day. Why not use a little tube of neon to indicate leaks and breaks in the ignition system? A trial in the laboratory showed that the idea was practicable. The idea survived passage through the development and manufacturing departments, and now the tubes are on the market, and the factory is turning them out the rate of four or five thousand a day.

There is an unending succession of such ideas, awaiting discovery by researchers. Some will lead to neat little devices; others will be epoch-making in their respective fields. Especially in metallurgy, the latest of man's major fields of industrial activity to become organized along modern scientific lines, lie opportunities for the researcher.

The handful of metallurgical researchers in Canada have had remarkable success. The production of electrolytic copper, lead and zinc at Trail and the successful treatment of complex ores; the separation of the conglomeration of useful elements in the ore of Cobalt; the solving of nickel problems, one after another; the economical treatment of rock containing three or four per cent. asbestos fibre—these attest a quality among our practical metallurgists that is worthy of emulation. But we must not forget that it is mastery of pure science that is, directly or indirectly, the foundation upon which all this progress is built.

EDITORIAL NOTES

It is interesting to note that Canada has at least a small share in the development of India's iron and steel industry. The superintendent of the mines and quarries of the Tata company is a Canadian. The general manager of the Bengal company has spent most of his life in Canada, and gained his professional experience here.

If, as is reported, it has been found possible to use an alloy of nickel and tin in the manufacture of tin-plate, Canada's place in the tin-plate industry may assume an importance from which her present lack of both tinstone and soft iron debar her. Nickel we have in abundance, or super-abundance, and soft iron for sheets we can make. To the prospector still remains the task of providing an indigenous source of tinstone.

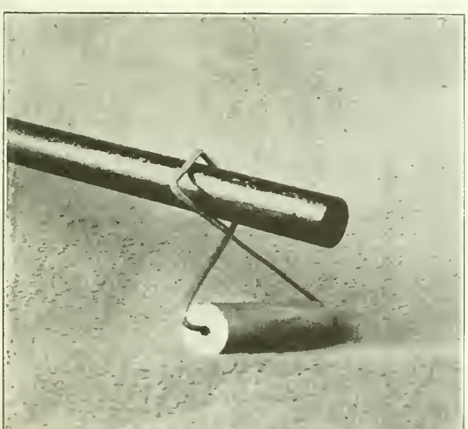
A press despatch announces "miners doing housework—spring cleaning this year has no horrors for the housewife in the anthracite coal fields." Presumably the strike is a blessing in disguise.

The reports of the commercial use of lignite and peat in numerous countries where cheap coal is not available lend interest to the attempts in Canada to use these low-grade fuels. The researches at Alfred, Ontario, and near Estevan, Saskatchewan, are being carefully and logically conducted, and merit close attention.

A ROLLER FOR LONG BARS

(Harry Moore, Montreal)

Where no proper facilities are provided, it is a common sight to see men dragging long bars of steel over the shop floor, cutting ugly grooves in the latter and incidentally giving themselves much needles exertion. One man who had work of this kind to do from time to time, made the simple little roller shown in the photo.



The roller itself is a piece of scrap steel with a hole in the center, through which passes a length of quarter-inch wire bent to form a Vee square as it were. The end of the round bar is inserted in this, and when the workman pulls at the other end, the wire grips the bar tightly between the Vees, thus holding it to the roller and keeping it square at the same time. Various size bars can be handled with this device, those that are too big to go through the wire requiring the services of more than one man to transport them successfully.

From by-product coke ovens in the United States the estimated recoveries per ton of coal charged during 1920 and 1921 were:—Ammonia (sulphate or equivalent) 21.4 lb.; tar, 8.2 gallons; crude light oil, 2.7 gallons, and gas, 10.8 thousand cubic feet. Gas production during 1920 amounted to 308,000,000 thousand cubic feet , of which about 10 per cent. was used in steel or affiliated plants, 20 per cent. distributed through city mains and 10 per cent. used under boilers, etc. Motor fuel production exceeded 55 million gallons, and benzine exceeded 16 million gallons. Other products were crude light oil, toluene, solvent naphtha, and naphthalene. About 7 per cent. of all coke made was sold for domestic and kindred uses.

TO THE RECENT GRADUATE

Acumen, vigour, both combined
With supermind omniscient,
Is what we're taught that we shall find
In graduates efficient.

I shall not say I've ever known
(I do not speak unkindly)
A graduate so god-like grown
That I'd admire him blindly.

I've met a few in knocking round,
And I've been disappointed—
They might be safe, they might be sound,
They *weren't* the Lord's anointed.

No genius rare anointed them;
No spark divine inspired them;
For if it had, alas, ahem,
Employers would have fired them!

They prospered only if they worked
And toiled *sans* intermission;
No graduate that ever shirked
Achieved a high position.

L'envoi

This highly moral verse I think
Exactly what it *should* be:
I wrote it with a solemn wink—
As wise a wink as *could* be.

In glancing over bank accounts
Of graduates I've *worked* with,
I see some very fat amounts,
Are owned by those I've *shirked* with.

ANON.

A Labour Leader's View

Glace Bay, Nova Scotia,
April 21, 1922.

Editor, Canadian Mining Journal,

Sir:—

You ask me to give you the men's side of the controversy between the British Empire Steel Corporation and the workmen. I suspect it would be superfluous to describe all the negotiations in detail, as most of that has been published over and over again in the press. You also state that I am considered a conservative leader, and people would appreciate an explanation of the situation from myself. I do not know what is meant by conservative; if it means that I would not ask or take so much as others, then I want to disabuse your mind on that, as I am like Oliver Twist in wanting more; or in other words I am out for all we can get. I look on this as the philosophy of both capital and labor that is the contentious part of our trouble. However, I take it that the public are more concerned as to the differences amongst ourselves.

When in Montreal from Feb. 27th to March 1st inclusive, we had an offer from the Company, of an additional 15c a day for day's wage men. The offer was made with the provision that we (the Executive Board) would make the recommendation to the men for acceptance. The Company had told us forcefully and solemnly that this was their final offer; consequently it appeared to us as a choice between two evils, strike, or acceptance. When all the complicated factors were considered, five of us decided to make the recommendation, the other three agreeing to remain neutral. But we had no sooner reached home than one of the five withdrew his support, and the others went out on the campaign against the offer. The result was a vote that gave a 7 to 1 majority against acceptance.

All dealings between company and men are conducted by a valuation of force. We make an analysis of the company's position, and no doubt the company does the same with ourselves. One of the executive officers found the men were much discouraged by the severity of the cut in wages, and were not doing so much work as usual; also the officials of the company were annoyed because of the increasing cost. This prompted the idea of pursuing a policy of irritation, namely "cutting down production", "strike on the job", "loafing on the job", "ca'-canny" or "sabotage". I could not agree with McLachlan on this policy, claiming that if we had not a chance by strike, then the Company would recognize our weakness and lock the men out, which would create circumstances equal to strike, and this would put us in a position recognized by all to be weak. This is only one of the many methods by which the policy could be attacked, and because of its many weaknesses I could not subscribe to it. On the whole it is a vicious policy; to quote Gladstone, "I don't want to use hard words, which are easily employed and as easily retorted, a game that two can play at". That quotation explains my position. If we play a vicious game what can we complain of if the company plays vicious too? We could have "crossed the Rubicon", the war would be on, there would be no retreat, it would be a matter of crush or be crushed. As we are situated, the Province of Nova Scotia cannot afford to have the company crushed; it is a source of livelihood to a large percentage of her people. We (the coal miners) will not be wise in our own interests, if we pursue a policy wherein a break is very probable. There is much good that can result from having an opportunity to meet the Company officials in negotiations for wages, working conditions, and a hundred and one small matters that are constantly cropping up amongst the 12,000 miners whom we represent.

The cut that was put into effect was very severe; some of our highly skilled contract miners would lose over $2.00 per day. I had secured a favor from the International officials excluding Nova Scotia from the economic factor amongst the rest of the coal miners of plete. This arrangement was made months before the big strike took place, with such advantage for the company and ourselves that it should have been the care of the company not to have asked for such a sweeping reduction. A contract for ten months, as is proposed, would allow them, if it were found our wages were out of proportion after the final settlement is reached in the United States, to have further adjustments.

Our hopes are now centred on the Conciliation Board about to be established. The findings of the same will go a long way to bring about the desired peace, which is necessary if the best returns are to be achieved for all concerned,—public, workmen, and companies. My aim has always been efficiency; to get such in mining, the co-operation of the men is essential. What the men want is an open game, where all the cards are on the table, where there are prospects of returns, and the knowledge that others, such as the consumers, are not being made to pay more than a fair price for the commodity we produce. With open arrangements such as outlined, better results could be obtained. There is just another grievance. Mining villages are most often built cheaply, companies possibly fearing that the life of the mine would not be of sufficient duration to warrant putting up expensive buildings. This in my opinion is a great mistake. It most often happens that the mine outlasts the houses. In this advanced age there should be no communities of any size without modern conveniences. The coal miner (that is the contract worker) is highly skilled; he works at a high speed, especially when young and vigourous. His average earnings, when everything is favorable, are much better than many other workmen, and the result is, that he is ashamed of the ancient methods of sanitary accomodation, and degenerate-looking buildings. Much could be done in this direction to give peace and comfort to those who produce that valuable material, coal which is of such great service to our present industrial system.

Yours, etc.

Robert Baxter.

The Tata Iron and Steel Company, Jamshedpur, India, possesses 25 square miles of territory. Its payroll contains no less than 35,000 names and involves a monthly disbursement of approximately $250,000. When numerous projected and organized subsidiary companies will have reached their full dimensions, Jamshedpur will reach the figure of a quarter of a million. The census returns gave the population at 71,000.

A Great National Industry

An Account of the Formation and Operation of the Canadian Car and Foundry Company, with its Many Plants and Diversified Products

The Canadian Car & Foundry Company, Limited, was incorporated in 1909, but the car building industry in Canada dates back to 1862, when Senator Nathaniel Curry and his associates, the Rhodes Curry Company, Limited, erected a plant at Amherst, Nova Scotia. In 1902 Mr. W. W. Butler was responsible for the commencement of the car industry in Montreal by the opening of a plant at St. Henry, for the manufacture of car bolsters and other specialties, which business grew so rapidly that, in 1905, a new plant was commenced at Ville St. Pierre which, in the following year, was extended and became the first steel car plant in Canada, under the name of the Dominion Steel Car Company. Just previous to the erection of this new plant, interests associated with the Pressed Steel Car Company, of Pittsburgh, Pa. had erected a plant adjacent to the property of the Dominion Steel Car Company, for the manufacture of wooden cars, under the name of Canada Car Company, Limited, and these three Companies were independently active until 1909 when, as a result of negotiations between Senator Nathaniel Curry, Mr. W.W. Butler and Mr. Max Aitken, now Lord Beaverbrook, these properties were amalgamated under the name of Canadian Car & Foundry Company, Limited. This amalgamation was formed to enable the car building industry in Canada to cope with the steadily growing demand for cars consequent upon the completion of the two Canadian transcontinental railways, and by reason of improved organization and adequate finances it was considered that the industry would be better to meet foreign competition and so develop, for the benefit of Canada and Canadian workmen, this most important business, which, owing to its many ramifications, provides work for a very large number of men.

The first President of the Company was Senator the Honorable Nathaniel Curry, who occupied this position until 1919, being succeeded by Mr. W. W. Butler who still remains the active head of the Company, Senator Curry now being Chairman of the Board of Directors.

During the first fiscal year of the new Company, the output consisted of 6,661 freight cars and 67 passenger cars, and, since its inception, up to and including its last fiscal period which ended September 30th, 1921, it has turned out, for Canadian railways, 70,000 freight and 1,200 passenger cars, and has exported to British Colonies and other countries 7,500 cars.

Shortly after the formation of the Canadian Car & Foundry Company, Limited, it became apparent that arrangements would have to be made for its requirements of steel castings, which were becoming more and more important in connection with car construction, and in order to control the supply of this necessary material it was decided, early in 1911, to secure the properties of the Montreal Steel Works, Limited, and the Ontario Iron & Steel Company, Limited, of Welland. At that time the Montreal Steel Works were the largest producers of steel castings in Canada and, besides their original plant adjacent to the Lachine Canal at Point St. Charles, they had commenced the erection of a modern steel castings plant in Maisonneuve, now known as the Longue Point Plant. The Ontario Iron & Steel Company had both a steel foundry and a rolling mill at Welland, located adjacent to the Welland ship canal. These three properties were amalgamated and now compose the Subsidiary Company, Canadian Steel Foundries, Limited.

All-Steel Tank Car for Russian Soviet Government.

Combination All-Steel Mail and Baggage Car for the C. P. R.

In 1912 the enlarged business of the parent company not only demanded a large quantity of steel castings, but also a very considerable amount of malleable iron castings which it was found difficult to procure in sufficient quantities to keep the car plants in continuous operation, and in order to prevent the periodical delays consequent upon the difficulty of procuring these castings, it was decided to acquire the corpany known as The Pratt and Letchworth Company, Limited, operating a successful malleable iron plant at Brantford, Ontario.

During 1911 and 1912 the requirements of the Canadian roads were such that the capacity of the car plants in Canada were taxed to the utmost and, in fact, were not sufficient to meet the demand, and consequently the Canadian railways were compelled to purchase several thousand cars in the United States. As a result of this a new plant was constructed near the head of the Great Lakes, at Fort William, so that within three years after the formation of the Company it had acquired, and still owns, the following properties:

Montreal, Quebec:	Dominion Car Plant, Turcot Car Plant and Foundry, etc., Longue Pointe Steel Foundry, Point St. Charles Steel Works.
Fort William, Ontario:	Car Plant and Shipbuilding Plant.
Amherst, Nova Scotia:	Car Plant, Rolling Mill and Grey Iron and Malleable Iron Foundries.
Welland, Ontario:	Steel Foundry and Rolling Mills.
Brantford, Ontario:	Malleable Iron Foundry.

The product of these plants is very diversified but, in the main, covers the following items:

Steel and Wood Freight and Passenger Cars of every type and capacity, from the modest mining or logging car to the luxurious dining or sleeping car.

Car Specialties such as bolsters, brake beams, side bearings, yokes, draft gear, pressed steel ends, springs, etc.

Manganese, Vanadium, Chrome and plain Steel Castings for all purposes, including the heaviest castings used in car and locomotive construction work, as well as in the manufacture of large machinery.

Manganese Steel and Built-Up Intessections and other trackwork for steam and electric railways.

Grey Iron and Malleable Iron Castings of all descriptions and from the most intricate patterns.

Chilled Cast Iron Car Wheels for steam and electric railway requirements.

Rolling Mill Products.

Drop Forgings of all kinds.

Bolts, Nuts and Rivets of all sizes.

Cabinet and Millwork, Kiln Dried Lumber, etc.

At the outbreak of war in 1914, the regular car business of the Company was practically brought to a standstill, but, owing to the energy and foresight of its officials, the Canadian Car & Foundry Company, Limited, was one of the first Canadian companies to engage in the manufacture of munitions, both for the British Government and its Allies. At the time the British Government first placed orders for the machining of shells outside of England there was no idea of the magnitude of this work, and the first order arranged for, in Canada, was for the machining of only 25,000 18-pounder shrapnel shells, 5,000 of which

Steel Frame Sleeping Car for Canadian National Railways.

were undertaken by this Company. Together with the Canadian Pacific Railway Company, it had also the distinction of drawing the first cartridge cases outside of regular Government arsenals, dividing equally with the Canadian Pacific Railway Company the initial order for 200,000 brass cartridge cases. Altogether the Company drew approximately 1,000,000 of these cases.

The Company also furnished steel billets and undertook contracts for forging and machining shells for the Canadian and American Governments, the following interesting figures showing the large amount of work carried out:

Steel Billets	189,632	NT (being approximately 10% of the total steel purchases by the Imperial Munitions Board in Canada).
Forged Shells	5,378,858	(being 8% of the total forgings purchased by the I.M.B. in Canada.)
Shells machined for the Canadian Government.	917,000	
Shells forged for the United States Government.	1,750,000	

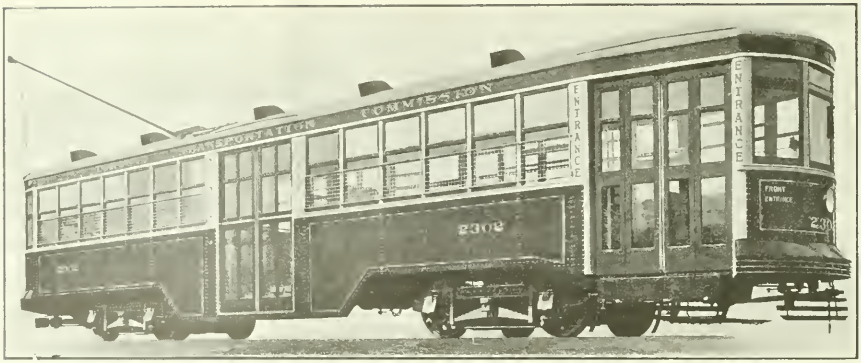
The Company also equipped a shipbuilding plant at Fort William and turned out twelve Mine Sweepers for the French Government. It also furnished cartridge cases and munition boxes, wheels and other war material, and received written testimony from both the British and United States authorities in appreciation of its efforts, and testifying to the good quality of the materials and workmanship.

In addition to the above, and in order to conserve its Canadian plants for the benefit of the British and Canadian Governments, the Company erected a plant in Kingsland, New Jersey, U. S. A. for the purpose of fulfilling a contract for the Russian Government covering 5,000,000 shrapnel shells. This contract involved an enormous amount of work, but would have been most successful had it not been for a disastrous explosion which completely destroyed the plant at a time when 2,000,000 shells were either packed, ready for shipment, or nearing completion.

During the war period, while the facilities of the Company were taxed to the utmost for munition requirements, it secured its full share of the car business offered in Canada, and shipped, in addition, cars for the use of the Governments of Belgium, France, South Africa and Russia.

After the armistice was declared and munition work was brought to a standstill, car building plants in Canada, in common with other industries, experienced considerable difficulties due to the reaction following the enormous war-time production. The curtailment of expenditure by the Government and the railways and the difficulty of developing export business owing to adverse exchange rates, and the fact that the car industry is, of necessity, the last to feel the benefit of improved conditions as it is not until then that a demand for additional railroad equipment is felt, made the re-organization period a difficult one; but the Company successfully re-organized its resources and re-vamped its plants, and has since carried out a large volume of business with both Canadian and foreign customers, including an order for the Russian Soviet Government for 500 Tank Cars, which was the first order of any importance placed by the Soviet Government in America. These cars were built in Montreal and were shipped in practically an assembled condition to the Black Sea, thus

Steel Frame Automobile Car.



Steel Frame Motor Car for Toronto Transportation Commission.

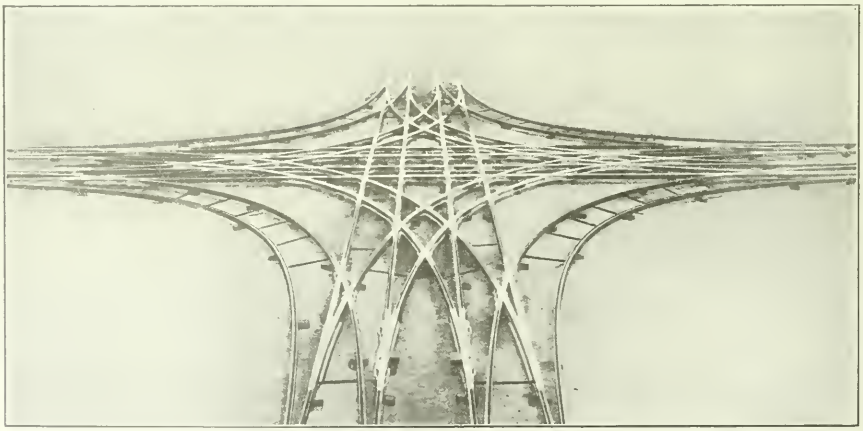
making a record for this class of work for Canadian industry.

The Company has grown to be one of Canada's foremost industries, its capital stock and outstanding bonds aggregating $20,000,000.00, while its total assets exceed $30,000,000.00. Under general conditions its employees number between 8,000 and 9,000, and its annual payroll $4,500,000.00 to $5,000,000.00, but, in addition, owing to its many ramifications, it is estimated that fully 30,000 people are directly dependent upon the Company for their living necessities, its annual purchases of all kinds during normal periods amounting to between $15,000,000.00 and $20,000,000.00.

The Head Offices of the Company are located in the Transportation Building, at Montreal, and it has an influential Board of Directors comprising the following:

Montreal: The Hon. N. Curry, Chairman of the Board, W. W. Butler, President, W. F. Angus, Vice-President, H. W. Beauclerk, the Hon. C. P. Beaubien, Francis H. Clergue, V. M. Drury, Wm. McMaster, Mark Workman.

New York: Lewis L. Clarke, Andrew Fletcher, A. Hicks Lawrence, W. H. Woodin, and the Hon. E. C. Smith of St. Albans, Vt.



Street Railway Intersection fr City of Calgary.

NEW IRON BLAST-FURNACE PLANT IN INDIA.

The last of three modern blast-furnace plants built in India during the last decade, will shortly be in operation. All three are in the province of Bengal. Their existence is based upon the considerable amounts of coking coal and the vast amounts of high-grade iron ore that occur in that province.

The Tata Iron and Steel Company is now well established, with blast-furnaces, steel plant, rail mill, and numerous other finishing mills. The Bengal Iron Company makes only the primary product, and after many vicissitudes, extending over half a century, is now a going concern, with a pig-iron production of 10,000 tons a month.

The latest arrival among the primary producers of iron is the India Iron and Steel Company. Like the Tata Iron and Steel Company, it has a plant of American design, and modern American blast-furnace practice will be followed. One furnace is now built, and a second is under construction. The plant will ultimately consist of six such furnaces.

President Butler

Mr. Wilson Workman Butler, President of the Canada Car and Foundry Company, is an American by birth, but like so many other of Uncle Sam's men, found his real opportunity for service in Canada. He came here some nineteen years ago, and after sampling our life and work, decided that he could not do better than cast in his lot with us, so about eight years ago took out naturalization papers, and to-day is a full-fledged Canadian citizen. He was born in Danville, Ohio, in 1862, and after a pretty thorough education in the Danville Select School, joined the John Shillito Company of Cincinnati. His real work was to come later when he joined the Sterlingworth Railway Supply Company, and from that concern went to the American Car and Foundry Company. When the present Canadian Car and Foundry Company emerged from the hands of Max Aitken, and started on its career as the chief supplier of rolling stock for the Canadian roads, the officials looked abroad to find a man capable of holding down the job. They found that W. W. Butler was the best man in sight, and took him from the American Car and Foundry Company, and made him Vice-President and Managing Director of the Canadian Car and Foundry Company.

The working head of the Canadian Car and Foundry Company is essentially a car builder and knows the manufacturing end from the group up.

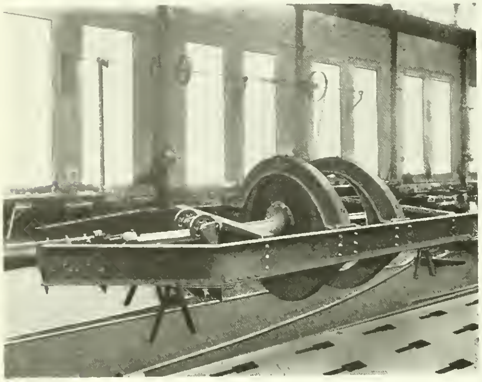
He has a big job on his hands, but is a big man physically and mentally. He has sufficient knowledge of the country, of its transportation problems, resources and possibilities to enable him to size up the situation with amazing ability. He is a hard worker and neither spares himself nor those associated with him. In brief, he is a big man holding down a big job in a big way.

Mr. Butler is devoted to fishing and has won great renown for his prowess in that sport. On the 7th ult. he landed at Puntagorda, Florida, the largest tarpon of the season. The fish weighed 160 lbs. and was six and a half feet long. He fought this monster tarpon for an hour and twenty minutes before landing it.

MR. WILSON WORKMAN BUTTLER

A CANADIAN STEEL MILL INVENTION

It is not often that Canada takes the lead in iron and steel matters. Consequently it is a matter for congratulation to find an indication of thorough-going initiative at one of our steel plants. The Algoma Valve is a Canadian device, and its permanent usefulness has now been demonstrated by over two years of continuous use.



Sixty-inch Algoma Air Reversing Valve, used on 75-ton O. H. Furnace.

The Algoma Gas or Air Reversing Valve was the result of a careful study of valve troubles common in Open Hearth, Reheating furnaces and Soaking Pits. It aimed to combine certain features of an ideal valve—long life; self-cleaning; no leaks; no water-seal; inexpensive to build and instal; no spare parts necessary; fool-proof. The final design, as now installed throughout the Algoma Steel Corporations works combines these qualities to a remarkable degree.

The valve consist essentially of one or move discs mounted on a reciprocating rod, which open and close circular vents in the circulatory systems of air and gas. All parts that must be protected from hot gases are simply and effectively cooled with circulating water: The apparatus can be modified so as to apply to almost any required valve problem.

Valve Enclosed in Brick-work.

IRON AND STEEL INSTITUTE MEETINGS

The Annual Meeting of the Iron and Steel Institute of Great Britain has been arranged for May 4th and 5th, in London. As usual, a programme of papers of first-rate importance has been arranged. Most of the subjects treated are highty technical, as befits the proceedings of an Instute that includes many of the world's foremost iron and steel technologists. The subjects to be discussed are as follows:

C. R. Austin: "Hydrogen Decarburisation of Carbon Steels, with notes on related phenomena."

N. T. Belaiew: "The Inner Structure of the Pearlite Grain."

H. C. H. Carpenter and Miss C. F. Elam: "Effect of Oxidising Gases at Low Pressures on Heated Iron."

F. Clements: "British Siemens Furnace Practice."

E. W. Ehn: "Influence of Dissolved Oxides on Carburising and Hardening Qualities of Steel."

A. F. Hallimond: "On delayed Crystallisation in the Carbon Steels: the Formation of Pearlite, Troostite and Martensite."

K. Honda: "On the Constitutional Diagram of the Iron Carbon System, based on recent investigations."

K. Honda and T. Kikuta: "On the Stepped A 1 Transformation in Carbon Steel during rapid cooling."

D. E. Roberts: "Notes on Blast Furnace Filling."

D. Selby-Bigge: "Recent Developments in Power Production."

A. Westgren and G. Phragmen: "X-ray Studies on the Crystal Structure of Steel."

J. H. Whiteley: "Formation of Globular Pearlite."

N. Yamada: "On the Heat of Transformation of Austenite to Martensite, and of Martensite to Pearlite."

RECENT ELECTRIC FURNACE INSTALLATION

The increased activity among the railroads and in the railroad supply field is indicated by recent sales of electric furnace equipment, reported by The Electric Furnace Company, Salem, Ohio.

A large western manufacturer of manganese steel castings for railroad purposes has just placed an order for a 250 K. W. car type Baily annealing furnace for one of its plants on the Pacific Coast. This equipment will have a capacity of 17 tons of manganese steel per day. The same corporation at present is using a furnace at 360 K.W.'s, with a heart capacity of 20 tons of manganese castings per day.

Another March order calls for a 125 K.W. melting furnace for ferro-manganese. This furnace is to be installed at the plant of the Pettibone-Mulliken Corporation, Chicago, and will be used for making hot additions to each charge from their Heroult electric steel furnaces. The Bailey unit will have a capacity of 1,000 pounds of ferro manganese per hour.

The Griffen Wheel Corporation has ordered a 75 K. W. melting furnace for melting bronze for railway bearings. This furnace will have a hearth capacity of 1,000 pounds, and will be installed at Tacoma, Wash.

The Best Foundry Company, Bedford, Ohio, a subsidiary of the American Stove Corporation, has contracted for a 50 K.W., 500 lb., melting furnace for melting its copper zinc alloys.

The use of electric melting furnaces, for both ferrous and non-ferrous work, is steadily increasing in Canada, where power rates make electric melting particularly attractive.

Safety Work in Nova Scotia

BY JOHN MOFFATT

Safety Work — a Good Investment

The efforts of the Safety Department of the Dominion Coal Company on the human side of the coal industry have not been sufficiently advertised by the Company to attract the attention of the public and inform them of what has been accomplished by means of organization and education. This lack of publicity on the part of the Company may be entirely due to a realization of the fact that prevention of accidents is considered part of the day's work, which effects the efficiency of the business and has therefore been organized into a separate department.

While this is no doubt true, it should be borne in mind that publicity and education are large factors in the work of the Safety Department, and through these same means the general public should get to know what is being done in the way of prevention of accidents and of the aid rendered when these do occur.

Experience has taught that the majority of accidents are preventable; that they occur either through the carelessness of the workman himself or of some other fellow - workman, or even of an official. Therefore, it is necessary that the fundamental principles of caring for his own safety and that of others should be inculcated, and habits of carefulness and forethought be formed. Safety Supervisors see that workmen are instructed, and that during working hours safety bulletins, safety posters and safety literature are ever before them, and their minds so filled with safety ideas that it is scarcely possible to forget that their own welfare is after all the first thing.

Safety and Insurance

A few facts and the principles of prevention of accidents having been imparted, these beget others, and so the training and the education of the workmen grows and spreads through all the works, and the industry becomes more noted for its low accident rate than for its great dangers. In this way the status of industries has been changed, and workmen who have been placed by Insurance Companies in the list of hazardous occupations have found themselves on an equality with men of the more favoured and less dangerous occupations.

The primary object of First Aid and Rescue work is to have sufficient specially trained men to take immediate charge of the situation, where life is imperiled through some serious accident, to give prompt and proper attention to injured men and to provide clean and aseptic dressings that will prevent infection in the wound.

When it is considered that infected cases require three times as long to recover as non-infected cases, there can be no doubt that the work of rescuing men is of the greatest value to the employer and employees alike.

The welfare, the comfort, the health and safety of the workingmen is being cared for by the Empire Steel Company. Much money has been expended in placing safeguards on machinery, in erecting new and up-to-date wash-houses at the collieries in modernizing the old ones, in establishing first aid stations at convenient places on the works, and on insisting that workmen who live in Company houses, shall keep the premises clean.

Safety Organization

The Safety Department is well organized, and is under the control of a Central Committee composed of the Executive heads of the Steel and Coal Companies. These men have had large experiences and meet periodically to consider and review all phases of Accident Prevention, to discuss and determine on all safety devices, to study the causes of serious accidents and to make recommendations which will tend to prevent a recurrence of these in future. Being in constant communication with other employers of labour and in close touch with bureaus of information, they are in a position to procure valuable information on the latest and best methods of accident prevention. This knowledge is passed on by way of instructions to the Safety Engineer and Safety Inspector.

A Sub-Committee composed of Colliery Superintendents receives and reviews all reports passing through the safety office and coming from colliery committees, and make their recommendations to the Executive Committee. Each colliery official is member of the colliery committee, which meets twice each month to discuss safety matters affecting the individual collieries.

The head of the Safety Department of the Steel Corporation is J. N. Worgan, Safety Engineer.

Alexander MacEachern is Chief Inspector of Mines. He is an experienced, capable and energetic official, who fully realizes that the safety of the collieries is in his hands. Under him are a number of trained men, whose duty it is to travel and inspect all workings and machinery of the collieries and make a daily report.

The Rescue Department is under the Chief Inspector of Mines, who sees that weekly instruction in use of the Draeger or oxygen helmets is carried on under capable instructors. A visit to the Draeger house at No. 2 Colliery, New Aberdeen, under the care of J. MacMahon, a man most proficient in both rescue and first-aid work, is a revelation to the uninitiated of what is being done along the lines of rescue and first-aid work. The Draeger house at No. 2 Colliery is one of the best equipped stations in Canada, and everything necessary for rescue work at the Colliery is to be found there, even to the merry little singing canary, so susceptable to the influence of mine gas, but rarely used except when mine explosions occur.

Hector A. MacDonald is Surface Inspector, having charge of the collieries, the railways, the machine shops and the piers. Mr. MacDonald is a young man, who has entered upon his duties with an enthusiasm that is contagious. Since his advent upon this work, safeguards of many kinds have been placed on machinery over the entire plant.

The Accident Report for the year 1921, is in some respects very encouraging. The number of fatal accidents in 1920 in the Glace Bay District was fourteen. The number in 1921 was eight, a decrease of six, or forty-three per cent. The fatal accident rate has fallen steadily since 1917. If the Glace Bay District were cut off from other parts of Nova Scotia and a comparison made with other mining countries, it would stand in the fourth place, taking rank after Britain, Belgium and France. It is a good showing, and proves

that much progress has been made. No fatal accident occured to workmen on the surface during the last year.

The non-fatal accidents in 1921 show a decrease of 5.4 per cent. over 1920. This is not as satisfactory as might be expected considering the outlay on organization and machinery. Unfortunately the system of checking up and investigating all but the more serious of the non-fatal accidents is not and cannot be an effective one until such time as the Government takes steps to improve it by legislation. Fatal and non-fatal accidents of serious nature are, because of their very seriousness, reported at the First Aid Stations where they have been treated. Minor accidents, such as cuts and bruises, are ofttimes not reported until the person applies for compensation. Investigation of all such cases after that is a mere matter of form, which may or may not find the facts as they really are. The attention of the Compensation Board has been called to such cases, but they say "that it is a matter for the Government." Herein no doubt lies one of the greatest handicaps of the safety department in its efforts to ascertain and eliminate the cause of accidents. Until such time as all accidents are treated at the Safety Stations, much of the work of the Safety Department must remain unseen, and the statistics of accidents will fail to give the reliable information so much needed.

Metal Trades in Britain

Iron and Steel

Conditions in the iron and steel trade have undergone little change during February. The general outlook seems to be gradually improving, although the actual amount of business passing remains, on the whole, rather small.

The reduction in Cleveland pig iron prices, has resulted in a fair number of orders beig placed and stocks have in consequence been materially reduced. Consumers are, however, still buying sparingly and seem disinclined to commit themselves to more than their immediate requirements. There is thus very little inducement for producers to increase output and they are generally maintaining existing production until the outlook improves sufficiently to justify the starting up of additional furnaces.

The recent increase in coke prices resulting from a sharp export demand for this fuel has introduced an unexpected difficulty which is likely to weigh with pig iron makers in the matter of increased production, and may also possibly cause disappointment to those consumers of pig iron who have been anticipating an early further fall in prices.

A satisfactory feature of the pig iron trade during the last few weeks has been the increase which has occurred in the volume of exports. The shipments from Middlesbrough to foreign destinations during the month of February are stated to have amounted to 25,434 tons, which is the highest monthly tonnage reached since April, 1920.

The general volume of inquiry for finished iron and steel is considerably better than a short time ago, but so far very little business of a substantial character has materialised.

British makers are now well able to hold their own against Continental competition as regards most classes material and in consequence are securing the bulk of the orders that are in the market.

Continental producers are suffering at the present time from shortage of fuel and prices have a tendency to harden.

The National Federation of Iron and Steel Manufacturers reports that the production of pig iron in February amounted to 300,100 tons, a figure higher than has been reached in any month since the coal stoppage began, but less by 163,500 tons than the production of the corresponding month last year.

The furnaces in blast at the end of February numbered 101 compared with 90 at the end of January and 193 at the end of February, 1920. Of the production of pig iron in February, 101,800 tons were hematite, 90,100 tons basic, 69,000 tons foundry and 20,000 tons forge.

The production of steel ingots and castings in February amounted to 415,000 tons compared with 327,500 tons in January and 483,500 tons in February, 1921.

The following table shows the average monthly production of pig iron and steel ingots and castings in 1920 and 1921 and in each month since January, 1921:—

	Pig Iron	Steel Ingots and Castings.
	Tons.	Tons.
1920: Average Monthly...	699,500	755,600
1921: Average Monthly...	217,600	302,200
1921:		
January	642,100	493,400
February	463,600	483,500
March	386,000	359,100
April	60,300	70,500
May	13,600	5,700
June	800	2,700
July	10,200	117,200
August	94,200	434,100
September	158,300	429,300
October	235,500	405,400
November	271,800	443,800
December	275,000	381,000
1922, January	288,000	327,500
February	300,100	415,000

ADDITIONAL MINES FOR REPLOGLE STEEL CO.

The Replogle Steel Co., with new blast-furnace plant almost ready for operation at Wharton, New Jersey, has enlarged its holdings of ore by acquiring the properties of the Engine Steel and Iron Company. The Replogle Steel Co. has now a total of 7 blast-furnaces, with a combined yearly capacity of 600,000 tons of pig-iron. These furnaces are operated mainly on ore obtained from the magnetic iron deposits of New Jersey and vicinity. The largest of these, the Wharton Mine, was estimated in 1919 to contain over 100,000,000 tons of crude ore, and since that time development has showed up additional ore.

Most of this ore needs concentrating. Coarse concentrates are fed to the furnaces direct. Finer concentrates are sintered. A feature of the concentrating mills is the use of sand tables, due to the non-magnetic quality of a large fraction of the fine ore.

The Welding of Foundry Products and Plant*

By C. W. BRETT,

Managing Director, Barimar, Limited.

In the past little or no attempt was made to reclaim units or components discovered to be unserviceable. A casting was good or bad according to the condition it was in when taken from the mould.

In drawing attention to this we are not, of course, criticising the attitude of foundry-owners to improvements in the actual process of fabrication. Our remarks are aimed at those who fail to realise the possibility of making good after failure, or who do not appreciate the fact that all plant and machinery contructed of any of the industrial metals is capable of being entirely restored to full service, when, through fracture, wear and tear, or other reasons, it is disabled and out of commission.

Now when any product, or producing unit, used in the metal trade is found to be defective or unserviceable, many men are of opinion that the scrap-heap is the only suitable place for it; since, on the one hand, the casting is evidently unsound, and, on the other, the machine is worn out. A colossal loss is annually incurred in this way through the assumption that, short of replacement, no reliable method of metallic reconstruction exists. Such an impression, of course is erroneous.

Actually something like 50 per cent. of the contents of the average scrap-heap can be rapidly, economically, and permanently rendered equal to new by the skilful application of one or other of the half-dozen welding processes.

Irrespective of the nature of the faults discovered, over 75 per cent. of defective castings can be repaired in such a manner as shall preserve their intended utility. Any reputable firm of welding specialists can, under definite guarantee, undertake the restoration of members composed of cast iron, wrought iron, steel, alloy steel, aluminium, bronze, or gunmetal.

Any doubts which may exist in the minds of foundry owners will be quickly dispelled by a perusal of the tests advocated by the recently inaugurated American Bureau of Standards (Welding), which prove conclusively that, in competent hands, repairs effected by autogenous fusion will yield 100 per cent efficiency.

In this connection, however, it should be pointed out that welding embraces several distinct processes, each having its specific use, and no welding concern can hope successfully to undertake general repairs—either to foundry products or plant—by the employment of only one process. Unfortunately for the prestige and progress of welding, this idea is too common, and is shared be many who are actually engaged in welding practice, with the inevitable result that the popularity and employment of welding is restricted. Under no circumstances can an unsuitable process produce a sound, efficient, and wholly satisfactory job.

Examples of highly effeicent work, done by skilled operators employing the right process, could be given without limit; but perhaps two cases recently dealt with will serve to indicate the scope and utility of this method of metallic reconstruction.

The first concerns the cast-iron frame of a punching and shearing machine, from which the table had been completely broken off. A new casting would have been extremely expensive, and would have entailed long delay before delivery—which, of course, meant that the unit would have been idle during many days, if not weeks.

Inspection showed that metal 4 1-2 in. x 16 1-2 in. had been fractured, and minor damage to other portions sustained. As the machine was required to stand very heavy work, the repair had to be an exceedingly strong one. A system applicable to cast-iron welding was employed, and suitable laboratory, workshop, and working tests were applied before the firm were satisfied that the unit could be despatched. The work occupied sixty hours, and was undertaken under definite guarantee. The saving to the owners in this case was considerable. The machine has now been in service for some time, and has proved itself equal to every demand.

Another job has reference to the cylinder of a pit-winding engine, which under exceptional circumstances, gave out at a very critical juncture.

The total weight of the cylinder was approximately 3 1-2 tons, length 5 ft., and bore 26 in. The damage consisted of cracks and fractures, which extended through flange and exhaust port at the one end, and for a considerable distance down the bore at the other end. The thickness of the metal involved varied from 1 1-2 in. to 3 in. The steam pressure normally carried by this cylinder is about 80 lbs. to the sq. in. The cost of replacement and the length of time required for delivery was a serious matter for the owners, who feared a shutdown for a long period.

It was decided, therefore, to try welding. The job, though it required careful handling and special treatment, was completed in a few days—including machining the bore and other portions—and tested to a pressure of 160 lbs. to the sq. in. before despatch. The work was undertaken under guarantee, and has since been working continuously without the slighest trouble.

Amongst the machines used in the foundry and kindred trades which have been reconstructed by the employment of common-sense welding are:—Core and mould-drying oven fittings, muffles, electric crucibles, moulding machines, boxes and ladles, steam hammers, shears, saw, hydraulic presses, borers, drillers, cranes, overhead gear, fans, sand mixers, weighing machines, and all descriptions of inter-departmental or road transport.

* From The Foundry Trade Journal.

SWEDISH IRON AND STEEL INDUSTRY

According to a report issued by the Swedish Board of Trade on the activity of the iron and steel industry during 1921, for every hundred men employed in mines working for export trade in 1913, only about 64 were employed on an average during 1921; the corresponding average percentage of men working in mines producing ore for home consumption during 1921 was only 45 per cent.; while, compared with 1913, the average percentage of men employed at blast furnaces was only 47 per cent. Compared with 1913, the averag number of furnaces in blast during 1921 was only 22 per cent.

Electric Cast Iron

The symposium on electric cast iron conducted by the American Electro-Chemical Society at their annual meeting in Baltimore during the last days of April, has made public some highly interesting data. The production of cast iron in the electric furnace, particularly in the basic electric furnace, is growing rapidly wherever cheap electric current is to be had. Published data on the subject are meagre, and the papers just published make a substantial addition to the records.

Cast Iron as Produced in the Electric Furnace and Some of its Problems

Under this caption, George K. Elliot, chief metallurgist of the Lunkenheimer Co., Cincinnati, carefully and impartially discusses the history of the use of the electric furnace for producing iron castings, its points of superiority over other methods, and its limitations.

In Britain and on the Continent, only sporadic use has been made of electric cast iron, and that mainly in the way of experiment. Presumably the cost of electric current is so high as to prevent any general use of the method.

The first every-day use of electric cast iron seems to have been made by the Lunkenheimer Company, who have used it consistently since 1917. At first the Heroult basic hearth furnace was used to melt a cold charge, but soon the "duplexing" process was instituted, wherein the cupola does the melting and the electric furnace the refining and super-heating. This duplex process is the one that is logical and that will persist. No other apparatus can melt iron so cheaply as the cupola; but as it is incapable of any refining and requires a pure charge to give pure metal, the electric furnace as an adjunct may pay in selected cases, particularly where castings of high quality are desired.

The refining of cast iron is possible only in the furnace with basic bottom, though the acid-lined furnace may aid the quality by allowing of the escape through floating of some of the impurities. The refining is brought about by the agency of reducing conditions due to a closed furnace and a slag composed of an excess of lime, a little fluorspar and coke dust. This gives the so-called "carbide" slog, which absorbs from the molten iron the larger part of the sulphur present and gases such as oxygen and nitrogen, as well as other impurities that are seldom recognized. Phosphorus cannot be economically eliminated, as that requires a separate treatment; but its presence is not deleterious in cast iron as are these other impurities.

The value of the basic electric furnace in making good castings is well illustrated by the fact that in about thirty minutes, iron with about 0.18 per cent. sulphur can be reduced to less than 0.07 per cent., which means the change from bad into good cast iron. As the world's scrap pile continues to hold an increasing amount of sulphur, and it is from the scrap pile that the cupola draws most of its charge, the growing importance of the electric furnace in the foundry business can be readily gauged. Still, the use of electric cast iron will, in all probability, always be limited to the cases where quality takes precedence over low cost.

Electric Furnace Iron and Steel Intermittent and Alternating Operations

W. E. Cahill discusses, under this heading, the foundry operations of the Alaska Treadwell Gold Mining Co., where he is metallurgist and foundry foreman. In this isolated locality Connellsville coke costs $48. a ton, and foundry pig-iron, $45. to $50. per ton. As hydro-electric power is available at a nominal rate of one cent per K.W.Hr., the production of electric iron and steel castings is a natural result.

Mr. Cahill gives an interesting series of data as the result of his observation. It was soon found that pig-iron was unnecessary. An all-scrap charge of machinery scrap melted and refined on a basic hearth results in a superior quality of metal. Refining takes place during the whole period of melting under the influence of a neutral or reducing atmosphere and a reducing slag, and by the time the bath has been raised to the required pouring temperature the sulphur has been brought below all limits required. Thus the sulphur problem, so serious where an all-scrap charge is used, is in this case non-existent. Phosphorus can be cotrolled by the addition of steel scrap, and silicon and manganese by the addition of the respective ferro-alloys to the bath.

For the satisfactory melting of a cold charge, it should not be too dense, else the electrodes will melt only the top and leave the bottom cold. In starting, a very low current is used until a good circuit is established. If insulation develops, the best remedy is to shovel in crushed electrodes, about walnut size, round the electrode giving the trouble. This carbon will afterwards serve to give the "carbide" slag its de-oxidising quality.

As soon as fuel current is on, the lime is shovelled in, to the extent of two per cent. of the charge, with sufficient sand and fluorspar to flux it properly. The resulting slag will contain sulphur up to about one per cent.

Electric furnace grey iron is characterised by a uniformly fine-grained texture. This is claimed by some to be due to low phosphorus; but it seems more likely that it is due to low sulphur and thorough de-oxidation.

The intermittent operation of the Treadwell furnace was found to be hard on both electrodes and roof. Nevertheless during three years only two of the carbon electrodes were broken, and these through defects of the threads, soon after the joint was made. In spite of intermittent operation, too, a roof has stood as many as 200 heats.

The making of cast iron and steel melts alternately in the one furnace added an unusual complication in this case; but clean pouring, which was possible with the high temperature obtained, prevented undue contamination of the new melt.

A Comparison between Shaft and Open Top Furnaces in the Manufacture of Pig-Iron Electrically from Iron Ore

R. C. Gosrow, consulting electro-metallurgist, of Buffalo, in discussing the above topic, shows himself to be a decided proponent of the open-top furnace. He considers that the saving of heat in the shaft furnace, as used in Sweden and elsewhere, is more than counter-balanced by the cheapness of construction and the simplicity of operation of the open-top furnace. He points out that in the open-top furnace the charcoal of the charge, being under no superincumbent load, is not crushed, and can be fed evenly and in small lots as the condition of the crucible demands. Also, the barring-down of the charge when

required and the removal of the inevitable accretions and "sows" from the hearth are more easily effected.

In the open-top furnace, the breakage of electrodes is much less than in a shaft furnace. The utility of plain carbon and graphitized carbon is about equal.

The estimated cost of the installation and operation of an electric smelting plant for iron ore has increased from $16.66 per ton-year in 1913 to $37.50 per ton-year at the present time.

A Study of Carburization in the Manufacture of Synthetic Cast Iron

In the course of an extended investigation into the production of "sponge iron" at low temperatures at Seattle, Clyde E. Williams and C. E. Sims, both of the United States Bureau of Mines, have conducted a series of experiments in small experimental electric furnaces, with a view to determining the influences of various materials and conditions on the carburization of a molten bath of iron. Then conclusions are as follows:

1. The results indicate that the carburizing ability of different forms of carbon decreases as the ash content increases and that the denser varieties of carbon are more effective than the more porous ones. Artificial graphite, resistor carbon, petroleum coke, and coal-tar coke give better results than the higher ash cokes or charcoal. Although the low ash content of charcoal would put it in the class with graphite, its porous nature prevents good contact with the metal. Graphite, because of its lower ash and higher density, has given slightly better results than any of the other forms of carbon used.

2. The presence of slag decreases the rate of carburization by tending to prevent contact between the metal and the carburizer. This action is more pronounced as the acidity of the slag increases. Lime slags counteract the deleterious effect of the high ash in coke, and, if conditions are right for the formation of calcium carbide, aid carburization.

3. Silicon carbide is an excellent medium for adding both silicon and carbon to iron. It cannot be used in the compartively inexpensive form of fire-silicon would be carried into the metal and also the cost would be too high. Silicon carbide should be used in the comparatively inexpensive form of fire-sand and in conjunction with one of the low-priced carburizers, such as coke.

4. Silicon has no effect upon the rate or the degree of carburization, although it may sligtly decrease the content of total carbon in the resultant pig.

5. Manganese seems to increase both the rate and the degree of carburization, although this increase is so small as to be negligible for the amounts of manganese ordinarily met with in commercial iron.

6. Phosphorus has no effect upon the rate or the degree of carburization, although, like silicon, if present in large quantities, it may decrease the content of the total carbon in the pig.

7. Sulphur probably decreases the rate and the degree of carburization. No attempt has been made to explain this unexpected action.

8. An increase in temperature from 1350 to 1450 degrees Centigrade has no noticeabble effect upon the carburization.

MOLDING SANDS

The Committee on Molding Sand Research under the guidance of Division of Engineering, National Research Council and American Foundrymen's Association, has made progress in its program of research. The U. S. Geological Survey and the various State Geological Surveys have promised to cooperate with the sub-committee dealing with this phase of the work under the chairmanship of Professor H. Ries, of Cornell Universiy. This sub-committee has prepared a letter of instructions to the State Geological Surveys, which will standardize methods of making the surveys of molding sand resources.

Work on standa[illegible]n of tests is well under way. Questionnaires have been sent out to gather information on the present methods of testing physical properties of sand. A digest of replies to these questionnaires is expected to be available shortly.

Many firms and universities have offered to cooperate in the research work. Every endeavor will be made to maintain their interest and to assign problems to those universities and industrial laboratories offering to cooperate; due regard being given to the facilities and talent available. A list of research subjects has been compiled, which is given in part below.

1. Recovery of used molding sand through restoring bond to the sand by subjecting it to contact with water vapor under high pressure.

2. The effects of additions of certain chemical reagents upon the physical properties of clays and clayey materials, such as molding sand.

3. Effects of water content on the bond and permability of a molding sand.

4. Effects of different water percents in molding sand on the milling and drilling speeds of light gray iron castings.

5. Research on fusion quality of facings (Function of "peeler").

. Tests of various kinds of clays for restoring bond to molding sand.

7. Comparison of lifes of different molding sands.

8. Effects on plasticity of bond in molding sand and reduction of water content when using oil.

9. Effects of wet and dry storing of sand on bonding quality.

Report of Sand Reclamation: The American Steel Foundries Co., has permitted a representative of the committee to to make a digest of the sand reclamation work carried on by the engineering staff of the A.S.F. and has assisted in the preparation of this digest. Because of the sercity of steel molding sand of the best quality and the problems arising from having to dispose of large quantities of refuse sand, this company has carried out an extensive investigation of methods of reclaiming the good material which is usually lost, whenever the so-called refuse sand is thrown away. After experimenting along different lines and thoroughly going over methods employed in other plants, a process of reclaiming old sand called "centrifugal scrubbing" was developed.

After establishing the principle of this method, equipment was designed which permits a recovery of about 70 p.c. of refuse sand. Cost figures for 1921 show that a ton of reclaimed sand costs about $1 per ton against the cost of new sand at the plant, of $2.65 to $3.85 a ton. The process involves cleaning the sand grains of adhering fused material, then separating by air currents the good sand from the bad material. Included in the 30 p.c. loss is some good bonding material which, because of its similarlity to bad material, cannot be economically separated.

The report covers the theory of sand reclaiming, centrifugal air scrubbing process, cost of reclaiming sand by the latter process, and a description of the proposed sand reclaiming unit.

IRON AND STEEL IN MARCH

Pig Iron and Ferro-Alloys

The output of pig iron in Canada during March showed a decided increase over the production during the preceding month and established a record for the present year with a total of 41,733 tons comprising 25,974 tons of basic pig iron, 10,123 tons of foundry iron and 5,636 tons of malleable iron. With the exception of 71 tons the output of basic iron was all used by the producing firms. Foundry iron on the other hand was largely produced for sale, the total under this heading being 10,080 tons with only 43 tons made for the use of the firms reporting. Compared with the preceding month, the production of basic iron was only slightly higher, but the output of foundry iron was almost 2,000 tons greater than in February. Malleable iron to the extent of 5,636 tons made during March was the first produced this year.

Ferro-alloys shaded slightly from 1,232 tons in February to 1,068 tons during March, the whole production consisting of ferro-silicon in the several grades.

At the close of the month there were only three furnaces in blast, two at Sault Ste Marie and one at Hamilton, the single furnace operated by the Dominion Iron and Steel Company in February having been closed down before the end of March.

The revival of the iron and steel industry indicated in reports from the producing centers in February gained a little strength during March and while the number of furnaces actually in blast in Canada at the close of the month was less than at the end of February, the output in Canada was appreciably higher, and to that extent more satisfactory than in the preceding month. In the United States the impetus to production which occurred in February was continued throughout March with the result that there was a net gain of 7,425 tons per day over the February record.

Steel Ingots and Castings

In spite of the advance in the production of pig iron during March the output of steel ingots and castings was much lower than in February, the total output being only 29,941 tons as against 42,388 tons in the preceding month. The decline was most marked in the production of basic open hearth steel ingots which in February amounted to 40,935 tons, but in the month under review totalled only 28,222 tons all made for the use of the producing firms.

Basic open hearth castings made during the month amounted to 678 tons practically all of which was used by the reporting firms. In February a very small quantity of basic open hearth steel castings was used by the makers but a larger proportion amounting in all to 472 tons was produced for direct sale.

Bessemer castings and electric steel made in March amounted to slightly more than 1,000 tons which was a little higher than the corresponding figure for February.

In the United States the production of steel during March showed a considerable increase over the output during the preceding month, and in Canada a general improvement in conditions in the steel industry was noticed towards the close of the month, although many plants were still operating at considerably reduced capacity. Dealers' sales were reported as having increased from 10 per cent to 25 per cent and a steady improvement was expected.

THE ACHING VOID

Not a thought is given by daily newspapers to the weakest link in Canada's industrial chain as exhibited in this partial list of natural mineral products in 1921 showing a value more than $1,000,000:

Coal	$74,273,000
Gold	21,327,000
Silver	9,185,000
Copper	7,459,000
Nickel	6,752,000
Natural gas	6,752,000
Asbestos	4,807,000
Lead	3,855,000
Zinc	2,758,000
Gypsum	1,725,000
Salt	1,641,000

Is Iron Mining among the lost arts hereabouts? If not, it is not far removed from the vanishing point, outside the Wabana section. Why not annex Newfoundland, if for no other reason than to enable us to have iron ore in the millions column? Or would we rather remain somewhat invertebrate? To have 43.1 per cent. of the total of mineral products represented in coal, and iron data freezing the mecury, as it were, makes it imperative that Canada become an Industrial Nation, and lose no time in doing it. There is salt on the tail of the bird, but we really need round shot.

Alexander Gray.

IRON INDUSTRY IN BRAZIL.

Brazil has now an indigenous and self-contained iron and steel industry, which is expanding rapidly. Particulars are given by E. L. McColl in a recent number of the Commercial Intelligence Journal, Ottawa.

The potential hydro-electric resources of Brazil are enormous, and a large fraction of the available power is close to the settled regions. Brazil also has very large and well-distributed deposits of high-grade iron ore. As there is no coal of good quality in the country (only some of inferior quality in the southern parts, which is used locally), Brazil is an ideal field for the application of electric smelting, and for some time has had an "Elektro-metall electric blast-furnace plant for the production of pig-iron, using charcoal as reducing agent. This plant is located at the Esperanca mine, at Itabira do Campo, state of Minas Geraes.

Recently the Anglo Brazilian Iron and Steel Company has been authorized to operate in Brazil. This company proposes to develop power at Manducaba, Argra dos Reis, sufficient to supply its own furnaces and mills, as well as to provide the near-by government railway with motive power when electrified. The company's charter calls for the construction, within four years, of furnaces for the production of pig-iron and steel, and for rolling mills and iron and steel foundries. The capacity of the plant must be equal to 50,000 tons of pig-iron per annum. The government agrees to buy from this company its supplies of iron and steel, **pro rata** with the other Brazilian producers. No information is furnished as to the style of smelting furnace it is intended to erect; but it can safely be assumed that it will be an electric furnace plant.

It is reported that a third company intends to erect an iron and steel plant shortly in the state of San Paulo.

THE BASSET PROCESS.

The methodical German has gone a long way towards exploding the claims made on behalf of the Basset process for producing steel direct from iron ore. This process is said to be put in operation shortly in France, and has been the subject of numerous press depatches.

According to a recent number of Stahl und Eisen, Basset's invention of a rotary kiln using powdered coal as fuel has been preceded by a number of similar inventions. The plan fyled with his patent application shows an inclined tube 40 to 50 metres long and 2 1-2 metres in diameter, enlarged at the lower end to provide a receptacle for the molten steel. Pre-heated air and powdered fuel can, it is claimed by the inventor, be burned to give carbon monoxide and un-combined hydrogen (from the coal), and sufficient heat from this incomplete combustion to effect the necessary melting of the reduced iron.

These claims are examined each in detail, and all are found to be impossible of fulfilment in combination. First of all, in the gas-producer, the most effective known commercial apparatus for burning carbon to carbon monoxide, some carbon dioxide is produced. The ordinary burning of powdered coal with a blast is much less favourable to the formation of carbon monoxide. It is likewise difficult to see how the hydrogen of the coal can be kept from combining with the carbon or oxygen present.

But the heat evolved in the reactions, and available in the furnace, give the clearest indication of the unsoundness of the Basset claims. A simple calculation shows that a good coal, burned to carbon monoxide and with its hydrogen burned to water has a theoretical combustion temperature of 2195 degree C. In regular open-hearth practice, this results in a temperature on the hearth considerably below that required to melt steel, a theoretical combustion temperature of at least 2500 degree C. being required for this purpose. To reach the required temperature, at least 30 per cent. of the carbon monoxide would have to be burned to carbon dioxide; and this would result in a mixture of gases that would re-oxidize the sponge metal it is claimed the kiln will produce.

Advantages claimed for the Basset process are low consumption of fuel, and low costs of labour, plant and production. Each of these is examined in turn, and from incontrovertible evidence gathered from existing plants, each of the claims is proved impossible of realization.

The British Empire Steel Corporation controlling the Dominion Iron & Steel Company, Dominion Coal Company, Nova Scotia Steel & Coal Company and Halifax Shipyards, moved on May 1st to the sixth floor of the new Canada Cement Building on Phillips Square, Montreal.

SINTERING PLANT AT BABBITT, MINN.

It was recently announced by D. C. Jackling that the new sintering plant at Babbitt would be ready for operation on April 30th, and that the first shipments of sintered ore would be made in June. The huge plant has been built with unusual expedition, due no doubt to the careful pilot work that led up to its design. Its operation is being watched with keen interest by many on this side of the border interested in the development of low-grade ore similar to those being treated at Babbitt.

A NEW SEAMLESS TUBE MILL

Lackawanna Tubes, Ltd., authorized capital, $525,-000., has begun construction operations at Welland, Ontario, where it has taken over the prperties of Welland Machine and Foundries, Limited.

The company has already placed some thirty men on their pay-roll and are adding more from day to day as required. When full production is attained, a labor stsaff of about 250 will find employment, so, on the usual basis approximately one thousand people will find their subsistence from this enterprise.

While the control of the plant is in the hands of United States capital, it is a distinctly Canadian corporation, and the great majority of the employees will be drawn from Welland, only the operating chiefs being brought in from across the border.

Seamless steel tubes, primarily boiler tubes, which will comprise the main product of the plant, have not been manufactured in Canada heretofore; so its establishment is of Dominion-wide as well as of local importance. On the basis of the company securing but one-fifth of the importation of similar products into Canada in 1921, a twenty-four hour day will be in order. This will be the only plant in the Dominion producing such tubes.

A portion of the machinery contracts have already been let. The old foundry is being repaired and put in first class shape. The company will require a foundry for some of their own repair work and will also continue its operation as a jobbing foundry, which is expected to prove an important branch of its activities.

The services of William Edestrand have been retained by the new company, and he will act as superintendent in charge of the foundry department.

L. Relyea Weeks, of New York City, is president of the corporation and its active management will be in his hands.

IRON AND STEEL INDUSTRY OF ITALY

That Italy will be one of the first European countries to recover from the effects of the war and to return to normal conditions, is the prediction made by Ernesto d'Amico in "The Iron Age" two years ago, and re-iterated recently.

During the past year the Italian iron and steel trade has suffered from the failure, through over-expansion, of two huge concerns, the Ansaldo and Ilva companies. Both have been re-organized, and are being operated on a more conservative basis.

The continuous shutting down of plants early convinced Italian steel workers that their only course was to stop agitations, accept reductions of wages and work steadily. Consequently there have been few strikes in the steel works during the year, and unemployment is much less than in the steel trade of other countries. During the war, the numbers of steel workers was largely augmented by men from the farms. Many of these have returned to agricultural pursuits, thus relieving greatly the unemployment situation.

The success of the Italian steel industry depends primarily upon a continuous supply of cheap hydro-electric power. Electric melting and refining furnaces, and the production of synthetic cast-iron are common practice. Mills, also, are almost invariably operated by hydro-electric power. Consequently the drought of the past season has been particularly hard on the Italian steel industry. In spite of this, the outlook is hopeful.

Index to Mill Supplies

This Directory is published in the interest of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

LESSONS FROM WASTERS*

There is one basic difference between normal steel works and iron foundry research, as in the former the receptacle for the material is fairly well standardised, whilst in the iron foundry an enormous number of variables can enter. To be more explicit, the conditions may be that in a steel-ingot shop the composition of the metal, the pouring temperature, the teeming speed, and the most suitable type of ingot have been determined, but in an iron foundry, even though all these have been ascertained and successfully reproduced, there is still no guarantee that a good casting will result. It may, perhaps, be interesting here to point out, for the benefit of steel-metallurgists and the mechanical engieer, the considerable number of causes which may operate to produce a "waster" casting. Primarily, it may be the metal, which can be of unsuitable composition, owing to one of a considerable number of variables being uncontrolled. Additionally, from the foundryman's point of view, it may be too hot, too cold, too hard, too soft, dirty or badly mixed. Apart from questions associated with ingot manufacture, the steel manager's problem is well on the high road to resolution, but the foundryman's has scarcely started, for on seeing a waster leave the mould he cannot at once ascribe it to defective metal, whereas a cracked, piped or blown ingot can immediately be relegated to metal trouble, as nowadays the pouring of the ingots is a fairly definitely established science.

The foundrymen obviously must hesitate in condemning the metal, for of equal importance is the sand employed for the making of the mould and the construction of the mould itself. Of the former, to quote the moulder's terms, the sand may be too wet, too dry, too open, too close, too strong or too weak. Here are factors about which there is only accumulated knowledge available, but no real research. Furthermore, it is ono which will retain moulding as an art rather than as a science for many years to come. Perhaps, in the distant future, it may be established that for making a casting of a definite weight and superficial area, the moulder must use a sand of chemical composition lying within a definite specification, and which admits of a definite grain size as measured by some standard means.

Whilst obviously this would be of the greatest utility to moulders, the problems of wasters would not be entirely resolved, for there still remains the construction of the mould, which again, according to the moulder, may be remmed too hard or too soft; the runners may be too large or too small, insufficient in quantity or badly placed; risers, too, are a matter for consideration, for whilst a necessity in some cases, they are sometimes the cause of the very trouble they are supposed to obviate. Other defects which cannot always be ascribed to either sand or metal are scabs (often a blacking trouble), run-outs, poured short, cracks, air locks and cold shuts.

The object of the above is to impress upon critics of faulty iron castings the very formidable list of contributory causes of wasters, but they will perhaps be more lenient in their judgment if they take into consideration the amount of money and work bestowed upon medical research and the birth of defective children, in comparison to the starved foundry and the production of defective castings.

Foundry work still remains an art, and until re-seldom an object "pour rire". The too-quick dismissal it into a science, then just so long will wasters continue to be made.

To the foundryman we would say, do not hide your wasters, for it is only by their close investigation can their repetition be avoided. Whilst they are never a thing of which to be proud, nevertheless, owing to the immense number of variables present, they are seldom an object pour rire. The too-quick dismissal of wasters is largely due to the fact that so few records are kept in many foundries associated with an absence of standard practice, so that on the birth of a waster it is impossible to ascertain from what direction the cause comes. There has been no deviation from standard practice, because no standard practice exists. A consultant can be of little help in the resolution of the waster problem until he can be given a true picture of standard practice.

* From Foundry Trade Journal.

WORLD RECORD FOR STEEL PRODUCTION, BY WEIRTON STEEL COMPANY

World records for production were broken last month at the Weirton plant of The Weirton Steel Company, Weirton, West Virginia. The blast furnace broke a record, and the output of the open hearth steel works was far in excess of any previous world record.

The blast furnace production for the month was 23,007 gross tons, making a daily average of 742.1 gross tons. In the open hearth steel works, the production averaged 7,017 gross tons per furnace. The previous world record for a month's production was 6,225 gross tons per furnace. Steel men will appreciate that this is a remarkable record for a plant that has been making steel for only eighteen months.

The Weirton Steel Company are large producers of tinplates, tin mill black plates, and hot and cold rolled strip steel, and are represented in Canada by A. C. Leslie & Co. Limited, Montreal.

In South, Middle and East Germany the development of electrical power is based upon the utilization of brown coal and lignite. In Saxony a State owned 200,000 horse-power electric station is in course of erection. Only brown coal will be used in generating this power. At another plant near Bonn, 8,000 tons of lignite are burned daily under 24 boilers. In most cases power from brown coal is cheaper than hydro-electric current.

The recovery of coal and coke from ashes and cinders is engaging much attention in Great Britain and the United States. In one recent test of the ashes from a large industrial plant it was found that they contained 57.8 per cent. combustible matter. Treatment by oil-flotation showed a recovery of 47 tons of coal (containing 15.2 per cent of ash) from every 100 tons of ashes.

-:- EDITORIAL -:-

CANADIAN FREIGHT RATES

On the sixth day of July, a few short weeks from today, the much-discussed Crowsnest Pass Agreement, suspended during the last year of the War, becomes effective once again—that is, the Agreement, being a statutory enactment, must be dealt with as such; it must be retained as it stands on the Statute Book, or abrogated. The only other alternative is temporary suspension, a makeshift piece of evasion.

The Agreement has been threshed out most pneumatically in the House of Commons. Some sense, and infinite non-sense, have characterized the debate. Incidentally, the puerilities that mark the interchange of exacerbities between the Premier and the Leader of the Opposition are creditable to neither. They do not make pleasant reading in Hansard.

The Crowsnest Pass Agreement was entered into by the Government of the Dominion of Canada and the Canadian Pacific Railway in 1897. The purpose of the Agreement was to bind the Railway to make reductions in freight rates for certain specific classes of merchandise in return for subsidies granted by the Government. Reductions were to apply on these specific classes of merchandise, whether in "carloads or otherwise," when shipped from any point east or west of Fort William, by rail, or by lake and rail. Thirteen classes of merchandise were enumerated, chiefly covering shipments of fresh fruit, agricultural implements, paints, household furniture, manufactured iron, glass, live stock, etc. At the same time a substantial lessening of rates on flour and wheat was agreed upon. The consideration, in the form of subsidies granted to the Canadian Pacific Railway, was something more than four million dollars, or about $11,000 per mile towards the construction and completion of its Croswnest Pass subsidiary.

As an extraordinary war measure, this Agreement was suspended by Order-in-Council on July 27th, 1918, along with all other rate-limiting agreements. The suspension lapses on July 6th, 1922.

To secure a just perspective we must contrast, very briefly indeed, the situation as it was a quarter of a century ago with that of today. When the Agreement was signed the Canadian Pacific was operating 7,400 miles of track, as compared with 14,000 miles at the present time. The subsidies mentioned above were designed to aid in opening up mineral lands and to have the effect of lessening freight rates until the volume of traffic should have increased to a point where such lessened rates would be profitable to the railway. At that time the shipment of fruit from West to East had not begun. Nor was the coal trade then much more than a hope. The value of the territory to be opened up, and the profit to the railway therefrom, were alike matters of pure speculation.

The scope of the Agreement was ill-defined. No understanding was arrived at as to whether it would or would not apply over all subsequent extensions of the Canadian Pacific. This is a matter yet to be decided. At best, the Agreement was a slip-shod attempt at freight-rate control.

It would be unprofitable to recite the numerous arguments for and against the further suspension of the agreement on July 6th. The central points of the whole situation are apparent. They are these:

The Canadian Pacific has vast reserves of physical assets and cash. It is a well-managed, dividend-paying institution.

The Government Railways are in desperate plight. They are not well-managed, neither are they dividend-paying. Yearly and daily they are piling up deficits.

The Board of Railway Commissions has no legal authority to deal with the Agreement.

Western members of Parliament are clamorous for renewal of the Agreement and for lower freight rates generally.

The Railway Managements claim that their earnings will stand no reduction.

Now, it does not seem to us to be meeting the question fairly at all, to urge, as do certain Parliamentarians, that the Canadian Pacific should be bled to ease the situation temporarily. Such a course would make Canada a laughing-stock. Nor is the gradual reduction of rates a remedy to be recommended; much less in any radical reduction. The problem can be summed up in a few words: How can our freight earnings be increased? From what source can new freight be derived in sufficient volume to justify a recession in rates?

The solution of the question demands statesmanlike qualities in those whom the nation charges with the task of solving it. Those of our representatives at Ottawa who have sufficient ability to form opinions based on the experience of other countries, will perceive the impossibility of making our railways pay and, therefore, the impracticability of freight rate reductions, before such time as our mineral industries have so advanced as to contribute at least twice as much to the freight traffic as they do at present. Principal among the minerals is iron ore.

The more attention Ottawa pays to the iron ore industry, the sooner will our railway deficits be replaced by surpluses.

BRAINS AND COMMERCIAL ENTERPRISE

In the address by Sir Robert Hadfield, of which we reprint an abstract today, this eminent metallurgist and researcher draws attention to the preponderance of British names in lists of the world's eminent scientists. From this he concludes that the pre-eminence of British industrial activities dependent on advances in science, is secure, at present and for a long time to come.

History, and particularly recent history, shows that the British mind is, above all others, capable of the deep and constructive thought that results in rending the veil that hides Nature's scientific secrets. We shall ever be proud of the records of Faraday, Dalton, Ramsay, Kelvin, and the host of brilliant scientists that our race has produced. In the practical realm of ferrous metallurgy, Britons have been particularly prominent, and we may add Sir Robert Hadfield's name to a long list of such as Thomas and Gilchrist, Bessemer and Siemens.

But to translate this innate ability into terms of this world's goods is a slightly different matter, and is a point that should not be overlooked. In another part of this issue we quote statements made by Dr. R. F. Ruttan of McGill University to the Society of Chemical Industry, of which he is this year chairman. Dr. Ruttan points out that, although the scientific brain-power characteristic of the motherland is not lacking in Canada, and although we have not neglected, in our schools and colleges, to develop this tendency, still we have failed to keep within our borders a large proportion of the scientists born, bred and trained among us. As has been aptly stated, most of our exports are of raw material; but here we have developed an export trade in finished scientists. Young Canadian men of science are much appreciated in the United States, where their efforts are (much more commonly than here) rewarded in a way commensurate with their abilities.

There is something wrong with our industrial system. It is, apparently, in the hands of men who do not fully appreciate the value to them of the trained scientist; else our young men would not have to go abroad in such numbers. We are a young country, with much more work to accomplish than our neighbor to the south; yet we can spare to them a large fraction of the flower of our youth, the cost of whose training has, by the way, been met largely from the public purse. It is time we bestirred ourselves to carefully examine this anomalous condition, and to look for a remedy.

Particularly does our ferrous metallurgy need attention. At the beginning of our present steel industry, American practice was adopted and Americans brought over to build and operate the furnaces and mills. This was quite logical and reasonable. But now we are in another generation, and can afford to do something more for ourselves. The metallurgical practice instituted at the beginning was that of the northern field of the United States using Lake Superior ore; we have no such ore. It was developed for use with Pennsylvania coal; in Central Canada we have no coal. Its technique is characterized by very large scale production; we have no domestic market for such a production, and little hope of a large export trade.

Here is an opportunity for the application of Canadian brains. Sir Robert Hadfield says we have good brains; of course we have. Sir Robert has applied his own abilities to the building up of a well-founded commercial enterprise of world-wide reputation. Let us do likewise for ourselves, instead of conducting our present export of finished scientists for the benefit, not of ourselves, but of our neighbors.

HENRY MARION HOWE

With the passing of Henry Marion Howe, the world loses a metallurgist of the front rank, and the United States loses a teacher and writer whose influence has been as wide as the bounds of his native country.

Dr. Howe was born at Boston, Mass., in 1848, the son of Dr. Samuel G. Howe and Julia Ward Howe. One of his earlier experiences in metallurgical work was in Canada. He designed and built the plant of the Orford Nickel and Copper Company, at Capelton and Eustis, Quebec. Latterly Dr. Howe specialized in the metallurgy of iron and steel, and most of his recent writing has been along that line.

Dr. Howe's outstanding faculties as teacher and writer have made him pre-eminent in both spheres. He was lucid and convincing in both. Much of the recent advance in the new science of metallography has been due to his efforts. His sterling character and his public-spirited endeavours won for him many honours during his lifetime. His name has a permanent place on the roll of honour of men of science.

STANDARD SPECIFICATIONS

Though Canada possesses no Bureau of Standards or similar department and must, until its establishment, depend upon the kind offices of her neighbors for many of the facilities and products of such a bureau, still the work of standardization is being carried on, consistently and thoroughly, along certain lines in which voluntary co-operative effort is the main pre-requisite.

The Canadian Engineering Standards Association, incorporated in 1919 by Dominion charter, issued last month a second edition of its first bulletin, *Standard Specification for Steel Railway Bridges*. This little volume of 78 pages is well worthy of the distinguished engineers who sponsor it, and whose names appear on its first pages. The work of compilation and correlation has been done with extreme thoroughness, both by the individual members of the committees responsible and in consultation.

To the initiative of the Engineering Institute of Canada and its predecessor, the Canadian Institute of Civil Engineers, is due the credit for having inaugurated this work in the public service. It is work such as this that provides the main warrant for the incorporation, as public bodies, of professional institutes and associations. Self-seeking motives seldom appear in charters, and should as seldom become operative in practice. The practice as well

as the expressed motive of these public bodies should be, as in this case, in the public service.

Such public-spirited voluntary effort as this will go a long way in providing economy in constrution and safety in design. But there is a point beyond which unpaid services cannot be expected to carry the work. It is this further effort that must eventually be provided for by the adequate appropriation of public funds and the establishment of a suitable bureau or department.

EDITORIAL NOTES

On September 21st, 22nd and 23rd next, the annual Fall Meeting of the American Electro-chemical Society will be held in Montreal. As one of the principal activities of this Society is in the line of ferrous metallurgy, this meeting holds special interest for our readers. Of particular import is the session on the Production and Application of the Rarer Metals, in charge of Dr. Bradley Stoughton, an old friend of Canada and Canadians. An increasingly large proportion of the rarer metals are used in the preparation of ferrous alloys. We in Canada have a virtual monopoly of the production of several, such as nickel and cobalt. There are great opportunities, still to be seized, for their commercial application and use, particularly by means of the electric current's aid.

It is announced that Witherbee Sherman and Company are to build a new, large-capacity blast-furnace at Port Henry, New York, to replace furnaces of older and less efficient design. This can mean only one thing — that the smelting of magnetic concentrate and briquettes in that locality is at present profitable, and that a lucrative market for the future is assured, so far as can be humanly determined The incident suggests that we in Canada are at present neglecting opportunities of a similar sort. At present only British Columbia's magnetic ore gives promise of being used. The various attempts to make profitable use of Ontario's magnetic ore have uniformly failed up to the present. Perhaps these attempts have been less consistent and thorough than those that led to the firm establishment of the iron industry at Port Henry. We may reasonably hope that the experimental work on the magnetite of Moore Mountain, Ontario, which is not yet concluded, will have a successful issue.

A very earnest and equally vocal United States Senator, whose name (it is not easy to believe!) is "Dial," passionately denounces any and all liberties taken with Standard time. The Senator is from the sunny South. Lord Byron wrote of the effect of hot climate on temperament. Senator Dial lends point to Bryon's verse. He condemns utterly those who dare meddle with the measurement of time as ordained by the Almighty!! Three cheers for the Senator! Let no scoffer arise and recommend treatment by "dialysis" for the Senatorial thought processes!

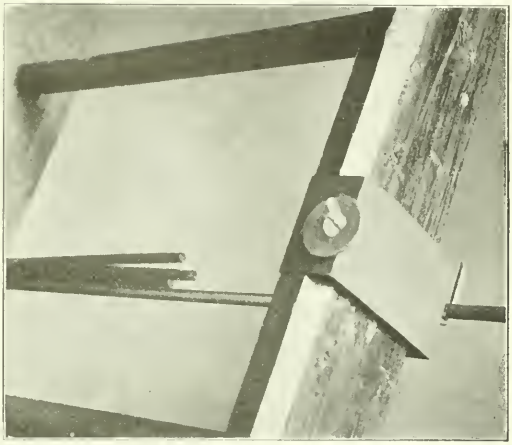
Another crusader against the evils of modernity is that dear old biological sport, Mr. Williams J. Bryan. With the perseverance of all the departed saints, Mr. Bryan is fighting the growth of evolutionary thought. Indeed, almost did he succeed in having the teaching of evolutionary principles expunged from the curricula of the State schools of Kentucky. Some sons of Belial accuse the ebullient editor of the "Commonwealth" of playing to the gallery. Fie! Fie! Mr. Bryan is a sincere ***devolutionist!***

A LADDER VISE ATTACHMENT

(Harry Moore, Montreal)

For want of a better name the attachment shown in the photo is called a ladder vise, because it enables work to be tightened to the side of a ladder in a manner similar to a bench vise.

Often it is a difficult operation to drag out a particular length of steel from a rack running along the storeroom wall, especially if the size required lies near



the bottom of a pile or is some distance from the floor, as most of the smaller diameters usually are. When the whole length of the piece is required there is no alternative, of course, but to pull it all out. It is when only a certain length is required that the usefulness of the device illustrated is shown, for by its use the stock can be sawed off without removal from the rack.

To make the vise, a piece of sheet-iron is cut and bent to fit the side of ladder, so that it will slide up and down, the ends being bent inwards but left short enough to clear the rungs. Next a hole is drilled or punched for a rod which is bent at right angles at one and the iron, after which the owing nut is tightened together with a washer rather large in proportion to the nut, forms the means for tightening the vise in place.

When it is desired to saw a length of rod, the ladder is placed in a convenient position and the particular rod wanted pulled out from the rest a distance a little longer than the length required. The vise is then slid to position and the work inserted between the bent rod and the iron, after which the wing nut is tightened and the piece sawed off in the usual manner with a hack-saw.

Easy to make and simple to operate, this attachment holds a rod securely while being sawed, rapid adjustment being effected by the single nut tightening the work in the vise and the vise to the ladder at the same time.

SHIPPING NOTES

By J. J. O'Connor

Appraisers have been busy for some time in the yard of the Port Arthur Shipbuilding Company, valuing the assets and plant of the company preparatory to its proposed entry into a merger with the Playfair interests of Midland, Ontario, comprising the Midland Shipyard, Midland Coal Docks, Midland Elevator, Great Lakes Transportation Company, and Glen Transportation Company. The two latter companies comprise a large fleet of the finest package freight and bulk freight steamers on the Great Lakes. It is rumoured that the Mathews Steamship Company may also join in the merger.

Should this consolidation of interests be consummated, it will constitute the largest industrial merger since the formation of the British Empire Steel Corporation.

The contemplated merger contains all the essential elements to meet the growing requirements of Canadian Lake transportation, ship-yards, ships, coal docks, and elevator capacity within itself. The combined interests will involve a capital of close to $10,000,000. It is reported that it is backed by four of the largest banking houses in Canada and the United States.

The Port Arthur Shipbuilding Company are engaged on the construction of a 12,000-ton lake ship for the Mathews Steamship Company. This ship is of all-steel construction, and of the most modern type of lake carrier, and will be ready to go into commission in September next.

The steamer "Midland King", recently in collision while upbound light for grain, with the grain-laden steamer "Glenfinnan" of the Great Lakes Transportation Company, about 40 miles southeast of Passage Island, on Lake Superior, is now in dock for repairs to her bows and port bilge, having sustained considerable damage to her plates and frames, for a distance of about 45 feet from the stem aft, on the port side.

Repair work at this yard has been quite extensive during the present season. With the rapidly growing shipping interests at the head of the Lakes, this class of work will continue to increase, as lake fleets are added to.

The Port Arthur Shipbuilding Company enjoy an enviable reputation for all classes of boilers and engines turned out by them, embracing all varieties. Their equipment and facilities for this class of machine work are not excelled on the Great Lakes.

They are also manufacturers of all classes of paper-making machinery, and are at present engaged on extensive orders for the Provincial Paper Company, and other Pulp and Paper Companies.

They have a highly efficient organization, and splendidly equipped plant. The ship-building section is under the immediate supervision of Mr. John H. Smith, and the paper-making machinery department is in charge of Mr. John W. Brassington.

PRODUCTION OF IRON AND STEEL IN CANADA DURING APRIL

The monthly report on iron and steel issued by the Dominion Bureau of Statistics states that pig iron production in Canada during April declined 9000 tons from the output reported in the preceding month, but an analysis of the output shows that 5000 tons more iron was produced for direct sale than in March of this year. The total pig iron production amounted to 32,572 long tons comprising 12,141 tons of basic iron; 14,952 tons foundary and 5,478 tons of malleable. Of the basic iron all but 104 tons was produced for the use of the makers. Practically the whole of the foundry iron on the other hand was produced for sale. The production of malleable iron was slightly lower than in March and amounted to 5,478 tons all of which was produced for direct sale.

Ferro-alloys, principally 75 per cent ferro-silicon, declined from 1,068 tons in March to 693 tons in the month under review.

The number of furnaces in blast remained unchanged. Two furnaces were operated throughout the month by the Algoma Steel Company at Sault Ste Marie and one furnace owned by the Steel Company of Canada at Hamilton was kept in blast.

In the United States the output of pig iron in April showed a gain of 3,395 tons per day over the March record and there was a net gain of seven furnaces in blast. The production of iron in April was probably slightly less because of the coal strike, although it is stated that so far the effect of the coal strike has been very small.

The decline in the production of steel ingots and castings in Canada noted in the March report was further accentuated during the month of April, the total output declining to 21,935 tons as compared with 29,941 tons in March. Included in the April production was 20,513 tons of steel ingots and 1,422 tons of direct steel castings.

Almost the entire quantity of steel ingots was made by the basic open hearth process and was used by the producing firms in further processes of manufacture. Of the direct steel castings made 1,338 tons was produced for direct sale and consisted of 630 tons electric steel, 537 tons basic open hearth and 171 tons of bessemer castings. The production of steel ingots and castings during April was the lowest recorded since monthly records of production have been obtained, and amounted to only 4 per cent of the average pro- and amounted to only 24 per cent of the average pro- output of steel ingots and casting in April, 1921 also established a low record for that year and totalled only 27,000 tons.

THE WELDING OF IRON CASTINGS

Mr. G. C. Carter, in a Paper read before the Cleveland section of the American Welding Society, states that in Cleveland there is one company where welding of iron castings in production work has been wonderfully systematised and almost perfect results have been and are being obtained. This company is the Ferro Machine and Foundry Co., where hundreds of automobile engine castings are made each day. When small blow-holes or other superficial flaws are noted in engine block castings, the castings are sent to the welding room, where they are pushed into a big annealing furnace which slowly heats them to a bright red heat. The properly-heated castings are then carried to welding stations, where the welders fill up the grooved-out places, using the usual cast-iron filler rods and fluxes. The welded castings are then carried to a sand pile, where they are buried until they have cooled slowly, after which they are sent along in the regular line of production.

Incidentally it may be noted that through use of a furnace which is heated by oil or gas there is a large saving in oxygen, acetylene and welding time, which more than offsets the initial preparation costs so necessary for quality.

The Enterprise of Crane, Limited

An Account of This World-Known Concern's Operations In The Dominion

The importance of Canada as a market for Power plant Equipment and Plumbing and Heating Material was the reason for the incorporating of Crane Limited under Dominion Letters Patent in February 1918.

To successfully and economically serve this market, it was deemed necessary to build a factory in Canada for the manufacture of valves, fittings, pipe equipment, etc., and after careful consideration, Montreal was chosen as the location for such factory, and an eight acre site was acquired at the corner of St. Patrick and Pitt streets on the south bank of the Lachine canal. This property was particularly suitable, being served by two railroads: the C. P. R., and the G. T. R.

In September 1918 work on the factory buildings was started, and the main buildings completed in July 1919; other parts of the plant being ready for occupation by July 1921. They comprise a main building of three stories and basement, a one story pipe shop, a one story pipe storage, a one story and basement building for core rooms, core ovens, annealing ovens and galvanizing kettles, a two story garage and stables, and two large warehouses for stock.

The main buildings, pipe shop, garage and stables are of reinforced concrete construction faced with brick; the pipe storage of brick.

On the top floor of the main building are the brass foundry, the cast iron foundry, the malleable iron foundry, and the brass cleaning and finishing division.

On the first floor are the mill room, the tapping and iron finishing division, the tool room, the pattern shop, and the plumbing and brass stock room.

On the ground floor are the finished stock room, the shipping and receiving division, the order department, and the general office. In the basement are the stocks of raw materials, the boiler room containing high pressure boiler used for testing, built and equipped for 350 pounds per square inch steam working pressure, the heating boilers, pumps, air compressors, and the main switchboard.

Electrical power is supplied to the building at 11,000 volts by a local Power Company, and is stepped down to the required voltage.

Large machines are direct-motor drive, the smaller machines being driven from overhead shafting.

The heating system is one of the most economical known: the heating boilers carry 15 pounds pressure, steam being reduced to 3 pounds in the heating mains; all radiators and pipe coils are trapped with Hoffman return line traps, and all condensation is returned direct to the boilers under pressure by Cranetilt direct return steam traps.

Main Building of Crane Ltd.'s Montreal Works.

The Sanitary equipment is complete and of latest design. Locker rooms and shower baths are provided for the employees. Shops and foundries are equipped with the most perfected safety appliances, which, combined with an efficient first aid department, keep accidents and their consequences down to a negligible factor. Plenty of windows and ventilators make the shops and all rooms light and airy, working conditions being the most hygienic obtainable throughout.

The Pipe shop adjoining the main building on the west is completely equipped with every facility for cutting, threading, bending, flanging, welding, and fabricating all sizes of pipe up to and including 18 inch.

In one of the warehouses are carried the stocks of boilers and radiators, enameled ware, porcelain ware, range boilers, soil pipe and soil pipe fittings; in the other, large iron

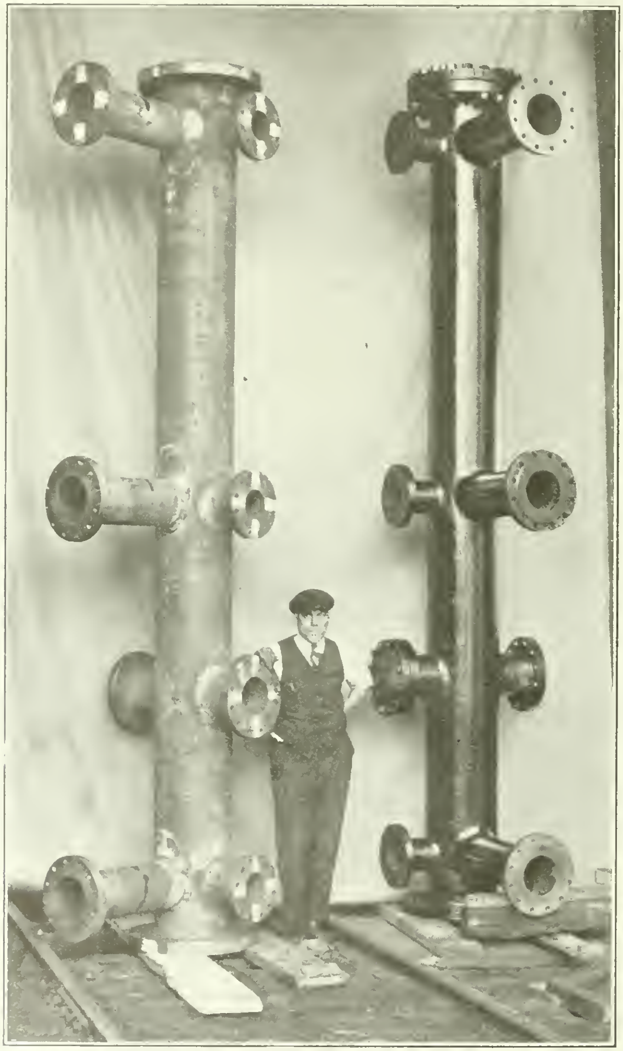
body valves, steam and oil separators, Cranetilt steam traps, and surplus stocks of pipe fittings.

Crane Limited now have a chain of offices, warehouses and branch houses reaching from coast to coast, located in the following cities: Halifax, St. John, Quebec, Sherbrooke, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Edmonton, Calgary, Vancouver and Victoria.

Full stocks of Steam, Plumbing and Heating goods are carried at Halifax, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Calgary and Vancouver.

Early in 1919 Crane Limited entered into the foreign field through their acquisition of the business of E. Bennett and Son Limited, London, England, which company is now Crane-Bennett Limited. Through this connection, offices have been opened in Birmingham, Leeds and Manchester, (England), Cardiff, (Wales), and Glasgow, (Scotland); and a factory at Ipswich, England. An office and distributor is maintained in Sydney, N.S. W. Through these arteries, Crane products are distributed to all parts of the British Empire.

With a view to following the Company's policy of giving the best service possible, Crane Limited recently purchased property in the heart of Montreal, on Phillips Place, extending through to Union avenue, where a five story and basement building is now being erected, which will contain the General office, Steam and Plumbing Show rooms, and City stores. On completion, August this year, the entire building will be occupied by Crane Limited exclusively.



Welded Pipe Headers Made in Crane, Ltd., Shops.

Everything possible in social work is done by Crane

Cranetilt Steam Traps Draining Vacuum Pans in Sugar Factory.

Limited toward the welfare of their employees. Free insurance is provided for every employee. Annual picnic with full pay. Frequent dances, and occasional dinners. Athletics are also greatly encouraged: the company provide tennis courts where tournaments involving nearly 100 entrants are conducted, covering a period of several months' elimination, single, double, and handicap competition being played off for cups and other prizes.

Bowling also arouses keen interest among Crane Limited employees, they partaking in three different leagues: Inter-departmental, Montreal Industrial, and the Crane Club league comprising 32 bowling teams from as many Crane offices all over America. The Canadian branch of Crane Limited, Winnipeg, was successful in winning this league's championship last year.

Baseball also proves very popular at lunch time and on Saturday afternoon, and a complete equipment is furnished the team by the Company. The national game of hockey is, of course, the most fascinating sport indulged in by Crane Limited employees, the whole force following their team through every game of the Montreal Manufacturers' Hockey League last Winter; no doubt this loyal support was a factor in the Crane Limited team winning the league's championship.

The Crane Limited Entertainment and Athletic Club arranges periodical "Gym" nights at a Y. M. C. A. branch; these are for the benefit of the employees' families, competitions being arranged for all members, ladies, men, and kiddies.

In the Fall of the year, an out-door athletic meet is conducted in concert with some of the other industrial plants, the entrants totalling well over 100; the usual events are held: 100 yard dash, high jump, the various relays, the football kick, etc.; this has had great vogue.

An educational programme wihch is very popular among employees is gone through every year during the Fall and Winter season. This consists in a series of lectures on different subjects relating to the Company's various lines. Questions are called for and answered in full, a paper being sometimes prepared on certain technical points by some of the department heads or specialty men.

Crane Limited employ normally 1000 people at their factories, offices and warehouses.

Secretary of Commerce H. C. Hoover called a conference of 1,500 bituminous coal-mine operators, in Washington on May 31st. The operators have been requested to put into effect a plan for the prevention of profiteering during the continuance of the strike. The plan is based upon the establishment of district committees to allocate all orders. Already fifty of the largest operators have given their approval and support This is tantamount to fixing the price of bituminuous coal at the mine at between $2 and $3

In reply to statements made at the White House by steel operators, to the effect that there are practical difficulties in abolishing the 12-hour day, and that foreign workers objected to the eight-hour day because it lessens their wages during a slump, Mr. Samuel Gompers, President of the American Federation of Labour, asserted that "the excuse that foreign-born workmen oppose the eight-hour day because it reduces their earnings is not alibi for the steel industry. It is unfounded, but even if true, it would be additional condemnation of the practices in that industry. The production of steel can and must be placed upon a basis where it affords an American standard of living with an American workday of eight hours."

The Work and Position of the Metallurgical Chemist

(Abstract of an Address delivered by Sir Robert A. Hadfield, before the Sheffield Association of Metallurgists and Metallurgical Chemists.)

[Editor's Note. Last year a deputation representing the Engineering Societies of the United States proceeded to England for the purpose of presenting to Sir Robert Hadfield, at a meeting of the British Institution of Civil Engineers, the *John Fritz Medal*, in recognition of his invaluable contributions to the science of metallurgy. On this occasion Sir Robert responded with an address in which he expressed his high appreciation of the honour conferred on him "as well as of the manifold kindnesses extended to him on many occasions in the United States, from his first visit in 1882 down to the present time." Sir Robert's address was published in pamphlet form and, later, embodied in the more extended paper of which the following is a summary.]

In his opening remarks Sir Robert touched on the vital help given to the Allies by the United States, referred to the part played by Great Britain, and alluded to the history of Sheffield and the industries there centred.

This summary, however, will be more readily followed by the reader if we interpose a few remarks about the donor of the *John Fritz Medal*. John Fritz was born in Londonderry, Pa., in the year 1822. His achievements in the realm of metallurgical engineering were remarkable. He was one of the creators of the Bethlehem Steel Works, and was the originator of the famous 100-ton steam hammer, the first of modern mechanical titans. On Mr. Fritz's eightieth birthday, in 1902, four United States engineering societies, namely, the Society of Civil Engineers, the Society of Mechanical Engineers, the Institute of Mining and Metallurgical Engineers, and the Institute of Electrical Engineers, subscribed conjointly to a fund to establish the *John Fritz Medal Foundation*, to commemorate for all time his life and works. The medal is conferred, irrespective of nationality or sex, on persons who have helped to advance the science of metallurgy. Mr. Fritz himself was the first recipient (1902), and the next, Lord Kelvin. The names of Mr. George Westinghouse, Dr. Alexander Graham Bell, Mr. Edison, Dr. James Douglas, and Mr. Orville Wright are included in the list of those similarly honoured. The honour was extended to Sir Robert Hadfield principally because he is the originator of manganse-steel-alloys.

* * *

One of the most illuminating points brought out by Sir Robert was the fact that the British Ministry of Munitions spent (1915-1919) the sum of £1,858,000,000 on munitions and materials. Taking the average price of pig iron before the war at £3 per ton, this sum represents the purchase price of more than six hundred million tons. It would take the blast-furnaces of the world about twelve years to produce this quantity!

The Chemist

Adverting to the work of the metallurgical chemist, Sir Robert has this to say:—"The chemist's work is arduous; in making his analyses he is often performing numberless operations, all of them requiring great care, as the slightest failure in any one will completely vitiate the final result. There can be no 'cooking' of figures; accuracy must reign supreme. During my life I suppose that hundreds of thousands of analytical results have come before me and I am delighted to say that I never remember a dishonest one being presented."

A tabular list of the names of the leaders of chemical thought is grouped into 15 classes, viz:—Iatro-chemistry (Roger Bacon, Paracelsus, Agricola, Glauber and Von Helmont); The Beginnings of Modern Chemistry (Robert Boyle and others); The Phlogistrians (Cavendish, Priestley, Scheele, Réaumur, and others); The Antiphlogistic Revolution (Lavoisier, Berthotlet and others); Electricity in the Service of Chemistry (Franklin, Davy, Farraday and others); Laws of Combination and the Atomic Theory (Proust, Dalton, Gay-Lussac, Berzelius and Thénard); Molecules and Stom Defined (Avogadro and others); Early Attempts at Classification (Liebig, Bemsen, Playfair, Roscoe and others); Theories of Chemical Action and Constitution of Molecules (Williamson and Frankland); Classification and Nature of Elements (Crookes, Mendeleeff, Ramsay); Physical Chemistry (Rumford, Tyndall, Maxwell, Kelvin, Rayleigh, Arrthenius, Thomson J. J., Ostwald, Walker, Remsen, and others); Stereo-Chemistry (Van T'Hoff and others) Chemistry of the Radio-Active Elements (Becquerel, Curie, Rutherford and others); Organic Chemistry (Pasteur, Thorpe and others); Modern Chemistry (Thorpe, Dean, Armstrong and others).

We have considerably abridged Sir Robert's list of names. As it stands, it comprises 52 British, 11 American, 15 French, 12 German, 5 Swedish, 4 Dutch, 2 Italian, 1 Swiss and 1 Russian names.

In a corresponding list of metallurgical chemists, chiefly modern, 77 British names are given, 39 American, 22 German and Austrian, and 25 French. Both lists are instructive and suggestive to the student.

Referring to British pioneers in the field of chemistry, Sir Robert says: "No other nationality can out do such a list, and certainly not Germany...Speaking of the German nation, I have never felt alarmed about their competition, whether mental or physical. It is true their industry and application cover a multitude of their sins, but I see no reason to think that they are superior men; quite the contrary.

"The early history of chemistry, in fact the recent past too, abound in names of English rather than Teutonic investigators...In the past the German played his cards so well that he earned a reputation which he really did not deserve...He capitalized on this reputation...until it required a great war to disillusion the rest of the world."

Sir Robert Hadfield's Research Work

Sir Robert Hadfield's research work has extended over 39 years. The results are embodied in 130 papers read before scientific societies and in numerous published articles. The most notable part of his labours has been the assistance he has constantly given to unnumbered fellow-workers, particularly in researches having to do with iron and steel alloys. Throughout this period he has maintained active co-operation with no less than 250 fellow-investigators in Europe, America and Asia. His work is doubly valuable because of the constant inspiration and help that he has vouchsafed to others. Here we may well quote the late Professor Floris Osmond, the eminent French metallurgist:—"The series of the Hadfield alloys had been prepared with a degree of technical skill which upset many falsely conceived ideas, resulting from imperfect preparation or from faulty manipulation. Had-

field's method was a truly scientific one, by means of which all the independent variables which could be disposed of were eliminated. With the materials for investigation thus prepared,. . .the results obtained were at once clear, coherent and definite. Moreover, Hadfield had not only made the best personal use of his wealth of material, but with never-failing generosity. . .he had placed it at the disposal of those inventors who were desirous. . .of using it for their own reseaches." Professor Osmond, continuing, remarks upon the conditions producing three essential types of iron; the first, soft iron; the second, hard quenched steel and its kindred alloys, and the third, non-magnetic, malleable steels which are very difficult to work by forging. "The first two had been familiar since the dawn of history; the third was due to the discoveries of Hadfield. Considered from this point of view, the discovery of manganese steel was not, therefore, a discovery only of a new alloy, curious and yet useful, but it ranked as a discovery equal in importance to that of the. . .hardening of steel by quenching." In the discoverer's own words: "It was the first voyage of the ship of modern metallurgy into the then practically unknown sea of ferrous alloys."

Hadfield not only developed the metallurgy of manganese steel, but he followed this with fruitful researches in alloying steel with silicon, nickel, chromium, aluminium and other elements. His extraordinary success is to be attributed in great part to the mose careful preparation of all materials to be tested, and to the willing assistants that worked under his direction from the year 1882 onward.

When his investigations were begun, very little was known of alloy steels, Mushet's self-hardening tool steel being the chief special steel in use.

Manganese Steel

In the year 1888, Hadfield read a paper before the Institution of Civil Engineers, giving an account of his discovery of the method of producing manganese steel and of the alloy's properties. The first specimens had been shown in September, 1882. The introduction of the alloy industrially was beset with difficulties. More encouragement was met in the United States than on the other side of the Atlantic. But prejudice and technical troubles have been overcome.

The immense importance of this alloy during the war is well illustrated by Sir Robert. Tens of thousands of lives were saved and severe head wounds prevented by the use of manganese steel "tin hats". Strange to say, this alloy was used only by the British, whose helmets were immensely superior to those worn by the French and German troops. To produce the British helmets, large ingots had to be reduced to sheets of only 0.036-inch thickness. Mr. J. Brodie, in conjunction with Messrs. Thomas Firth and Sons, Sheffield, have the credit of introducing manganese steel for this purpose. Shrapnel bullets, at as low a velocity as 350 feet per second, would easily perforate the French helmet. The German helmet, though heavier and thicker, was similarly susceptible to shrapnel. The British helmet resisted shrapnel bullets up to velocities of between 750 and 900 feet per second.

Sir Robert informs us that during the very week in which the Armistice was signed, the French Government sent a special Commission to London to interview him on the practicability of supplying the French army with large numbers of manganese steel helmets. Amongst numberless other special applications of the alloy, its non-magnetic quality made it wonderfully useful in the construction of marine mines. The absence of magnetism rendered detection by the enemy more diffifcult.

Low Hysteresis Steel

Low hysteresis steel is an alloy of iron and silicon. Hadfield announced his discovery of this new combination in a paper read before the Iron and Steel Institute in 1889. The heat treatment of the alloy was also evolved by Sir Robert. Under low magnetizing forces, this steel is even more magnetic than iron itself, and largely reduces the waste of energy previously met with from hysterisis and eddy current. It is now universally used in the construction of transformers and other electrical apparatus.

From authoritative data, Sir Robert has estimated, approximately but conservatively, the annual saving to the world that has resulted from this discovery. The saving in coal is about five million tons per year, or at least £7,000,000 for this item alone. The saving in the smaller quantity of copper required in the new types of transformer is great, but is not calculable. Neither is the saving of space calculable. Moreover, low hysteresis steel does not age,—in fact it improves with service. With the old transformer materials, energy losses were appalling. Sir Robert mentions one case where a battery of transformers showed a loss of 20 per cent. after a year of service; that is, nearly one-fifth of the coal employed to generate energy was being thus wasted.

The head of the research laboratories of the Westinghouse Electric Company estimates the total saving brought about by Sir Robert's discovery, up to the present, at not less than $340,000,000, or "nearly enough to build the Panama Canal."

* * *

Sir Robert's address is replete with interesting references and allusions of the most varied character. He alludes, at some length, to the history and work of the Royal Society, which was granted its charter of incorporation in the year 1662, and of which King Charles II was a distinguished and enthusiastic patron. The Society's membership has embraced, for two and a half centuries, the flower of British scientists—Isaac Newton, Count Rumford, James Watt, Benjamin Franklin, Stephenson, Huxley, Tyndall, and a host of other leaders. It may be noted that in 1753 Benjamin Franklin was awarded the Copley Medal, the highest honour in the bestowal of the Royal Society. Three years afterwards he was elected a Fellow. His name was entered as a member along with a record of a Council resolution that he was not to be required to pay an entrance fee.

* * *

In his concluding remarks, Sir Robert quotes a Latin sentence written by Oliver Cromwell in a prayer book. It reads:—"Qui cessat esse melior cessat esse bonus." Freely translated, this may be rendered:—"He who ceases to aim at better things will cease to do good things."

ELECTRO-DEPOSITION OF IRON

In view of the extended use of electro-deposited iron for many industrial purposes, the Department of Scientific and Industrial Research (Great Britain) has considered it advisable to issue a bulletin (No. 6) which embodies the results of research carried out by Mr. W. E. Hughes, with the assistance of grants made by the Department. The contents of the report are arranged under the following headings among other:—(1) Introduction. (2) General note on the description of the deposits: (*a*) On the effect of temperature; (*b*) current density; (*c*) mechanical movement. (3) Introduction to theoretical part. (4) The crystallisation of substances in general. (5) Application to electro-deposited metal. (6) Workshop application. (7) Bibliography.

British Iron and Steel and World Trade

(Abstract of paper read, April 21st, by H. Cole Estep, before the Staffordshire Iron and Steel Institute.)

The next two or three years will undoubtedly determine whether British production and export trade in iron and steel is going to regain its former pre-eminence or sink to a subordinate position. At tremendous cost to itself, the industry is setting its house in order, and is now in a position to hold its own in the world.

Since England is America's greatest single customer, the United States would cordially welcome the complete rehabilitation of British iron and steel manufacture. In what follows, an effort will be made to portray the British situation in comparison with that of other countries. The writer feels that the position of the British iron and steel industry is not by any means as desperate as has from time to time been made out.

Production

In 1921 Great Britain produced 2,611,400 tons of pig-iron, compared with 8,034,700 tons in 1920 and 10,260,000 tons in 1913, this last being a year of maximum output. The coal strike and bad trade account for these figures. It is well to note that pig-iron production in the United States fell from 36,925,987 tons in 1920 to 16,688,126 tons in 1921.

The 1921 production of steel ingots and castings in Great Britain last year was 3,625,800 tons; that of 1920, 9,067,300 tons. A similar decrease was noted in the United States. Even in abnormally stimulated Germany, the output was only 60 per cent. of capacity.

But production statistics, even those of the most recent date, form merely a jumping-off place for any discussion. It is the statistics of the future, and not those of the past, that are of primary iterest to business men.

Wages and Output per Worker

Except for the United States and Great Britain, there seem to be no reliable wage statistics available. The average weekly wage of iron and steel workers in the United States has been reduced from £9-4s.-6d.; January 1921, to £4-8s.-0d. This is still considerably higher than that paid in Great Britain, where the reduction has been from £4-16s. 8d. to £3-1s.-6d. At present, British wages in general seem to be 25 per cent. under those paid in American steel works.

The only reason why United States iron and steel works can compete in such markets as South America with the output of British works is on account of the larger output per man obtained in the newer country. Here we touch upon one of the problems that the British iron and steel industry has still to solve.

The average production of the United States Steel Corporation in 1921, was 57 tons of steel ingots per man; in 1920, 72 tons; in 1917, 76 tons. The corresponding figure for workers in Great Britain was 46 tons. Whilst there are perhaps half-a-dozen plants in Great Britain approaching the higher output per man, yet there appears to be an excess of antiquated plants. Bringing these up to the level of new works will involve large expenditure and much scrapping of existing equipment, and is therefore a problem that can only be solved over a period of years.

The average output per man in Germany is about 60 tons, or some 14 per cent. less than the American standard although considerably above the British standard. Any menace that may emanate from Germany will be found to lie in this field of labour efficiency rather than in any advantage Germany may possess from a temporary dislocation of the rate of exchange. Wages expressed in marks have more than doubled during the past six months, and the end of this inflation is not yet in sight. The ability of German iron and steel makers to get out more tons per man than in British works is a far more serious matter, in the writer's estimation, than the exchange situation.

Lower Wages in France and Belgium

At the present time a common workman in the Lorraine or Luxembourg steel plants earns about £2 per week, as contrasted with £3-15.-6d. in Great Britain; but there are compensating cost-factors everywhere on the Continent which to a large measure vitiate the advantage shown in the wage rates alone. So far as wages are concerned, Great Britain has an advantage compared with her great American competitor, and a disadvantage with reference to her Continental neighbours.

But Great Britain has an advantage over Belgium, France and Luxembourg in the lower price of coke, and in the near future the best German coke will probably be about the same price as British coke. The latter is also about 1s.-6d. lower in price than United States coke.

Iron Ore

The advisability of using only a portion of native ores in any European furnace, and using ore higher in iron to raise the furnace burden, probably offsets the higher prices paid for imported ore in Great Britain. American ore delivered to lower Lake ports is today about 28s. per ton. As far as both ore and fuel costs at the furnace are concerned, British pig-iron producers have a slight advantage over their American competitors. But this is neutralized by the fact that in Great Britain the average blast-furnace has a daily capacity of 77½ tons, whilst in the United States it is 334 tons. Coke consumption per ton of pig-iron is 1.20 tons in Great Britain; in the United States it is 1.015 tons. Thus the higher price of fuel in America is balanced by the lower consumption.

British scrap is at about the same level as is American, and both are much lower in price than on the Continent.

Fairly Favourable Position

British iron and steel producers are thus in a favourable position with reference to ore, fuel and scrap; and their wage costs, while lower per hour than those of the United States, are perhaps higher per ton than any of their competitors. Increasing the output per man will accomplish more than further reductions in wages.

A year ago the United Kingdom's export quotations were almost invariably higher than those of any other country. Today, British prices are either at a near the bottom of the list. If the volume of business were satisfactory, present prices would not be as unprofitable as they are with the current limited tonnage.

Current British exports of iron and steel products are at the rate of 93 per cent. of the monthly average for 1920, when market conditions were unusually flourishing. But compared with the average of the two years prior to the war, they now show a falling off of about 38 per cent.

International trade in iron and steel probably reached the lowest point it will touch for some time to come, last July. France, Germany and Belgium are growing relatively weaker, and Great Britain and the United States stronger, in export trade.

Germany's Handicap

German exporters are handicapped at the present time by difficulties in quoting firm prices for future deliveries. Uncertain conditions necessitate prices being quoted *frei leibend*, or subject to increases without notice to the purchaser. The German producer must be prepared for rapid changes in the value of the mark. Thus Germany will not this year be as serious a competitor of Great Britain as will the United States.

France exported iron and steel last year to the amount of 1,620,800 tons, nearly three times as much as her best pre-war record. While France will continue to be a strong factor, she, like Germany, was specially favoured in recent months, and is now facing more adverse conditions. The very high cost of coke is a serious matter.

Belgium's export trade has reached a low ebb on account of labour troubles and other difficulties surrounding production. However, Belgian prices are now on a fairly favourable basis.

Trade in Specific Areas

The greatest steel-consuming, as distinct from producing, districts of the world are South America, Southeastern Asia, China, Japan and Australasia. To these may be added certain countries in Europe, such as Spain and Italy. All these countries combined produce not more than 1,400,000 tons of pig-iron in a year, while their annual consumption of iron and steel products exceeds 10,000,000 tons.

In South America, Germany had the lead before the war, with the United Kingdom second and the United States third. Great Britain now leads, with Germany second and the United States third, although during the war the United States had a practical monopoly of the trade.

In that part of Southeastern Asia extending from Karachi around to French Indo China, the increase of British exports has been remarkable. Exports for January of this year were 68,000 tons, slightly in excess of the monthly average for 1913. Germany, too, has made gains in this territory, but they have been nothing compared to those of Great Britain. American exports are rapidly resuming their pre-war position of about 3,500 tons monthly.

It is possible that the British iron and steel exports may take in the Gulf States and Pacific Coast districts, but this would not likely assume any considerable volume.

The British home market, given over bodily to foreign producers last summer, has been practically all recovered. The present small volume of business is due in great part to the tremendous slump in shipbuilding. The effect of high railway rates is also a drawback, though this has been sometimes exaggerated.

Effect of Trade Agreements

From an outside point of view, it might appear that some of the trade combinations and agreements among producers to maintain prices, are perhaps detrimental to the general welfare of the country. Free competition is certainly a great factor in raising the general efficiency of industry. Though a ruthless instrument, because it drives inefficient concerns out of business, in the long run it has a beneficial effect.

In the United States, in spite of the fact that one corporation produces about one-half the tonnage, competition is exceedingly keen, and a large number of independent producers are constantly operating along their own individual lines. Furthermore, the law against trade combinations is trictly enforced. Fifteen years of free competition in the United States tends to indicate that there is something to be said for it.

Salesmanship is another phase of the problem. In times like the present, iron and steel must be *sold*. It is not sufficient merely to name a price and sit tight.

The function of technical research is to reduce the cost of production and develop new products. The function of industrial research is to develop new uses for existing products, and trade in new markets. In 1920 the production of steel in the United States was 820 pounds per capita of the whole population; in Great Britain in the same year it was 450 pounds. No one would expect British output to reach the American level, owing to the fundamental difference in the two countries. But the question still remains whether the British iron and steel industry should be content with an output of 450 pounds per capita, in view of what is achieved elsewhere.

Industrial research certainly proves that there is no such thing as a fixed quantity of demand even for iron and steel.

TIN

Periodically there are statements that a satisfactory substitute for tin for plating has been found; but still tin remains the principal means of protecting iron from rusting. In its recently published bulletin on *Tin* 1913-1919, the Imperial Mineral Resources Bureau has brought together comprehensive information about the tin resources of the Empire, and a summary of the world's resources, annual requirements and past production and use.

The only important ore of tin is cassiterite, the oxide. The great bulk of the world's output is derived from alluvial deposits. Vein workings are as yet unimportant. The present methods of smelting tin are essentially crude, and electrolytic refining has not yet been brought to a point where its advantage over older methods is firmly established.

A graph, showing average prices per ton for 140 years, indicates a widely fluctuating market. In 1870, the price was less than £70 per ton. During the later years of the Napoleonic wars, the price rose to nearly £160, fell thereafter, rose again during the Crimean campaign, and then displayed irregular movements (approximate periods of high prices recurring every 5 or 7 years) until the late war, when the ascent to £380 per ton was spectacularly rapid. Of late years it has fallen once more, the present price being round £165 per long ton.

Of the world's total output, the British Empire contributes slightly over half. In this production the Federated Malay states are by for the largest factor, Australia coming next, followed by Nigeria, United Kingdom and South Africa in order of naming. Of foreign countries, Bolivia ranks highest, contributing about one-fifth of the world's total, the Dutch East Indies ranking a good second. The aggregate smelting capacity of the various leading consuming and producing countries exceeds the annual supplies of ore, considerably.

It is somewhat anomalous that, while the United States consumes more than 40 per cent. of the world's production it produces practically no tin. In both the United States and Canada there have been local flurries over the discoveries of tin-bearing veins in granite and granite-porphyry dykes; but nothing has come of them.

There seems to be no valid reason why payable tin deposits should not be discovered in the northern half of this continent. Incidentally, tin may be replaced in commerce by other metals, but there will ever be a strong demand for it.

Iron and Steel Institute

ANNUAL MEETING, LONDON, MAY 4th and 5th, 1922

(Abstracted for Iron and Steel of Canada by Bernard Collitt, F.I.C., F.C.I.C.)

At the Annual Meeting held in London on May 4th. and 5th. many papers were presented dealing with different branches of the industry, or with the metallurgy of steel. Three papers gave consideration to the efficiency of certain operations in the industry, whilst the other contributions described results of laboratory investigations into various problems connected with iron-carbon alloys..

Blast-Furnace Filling

"Notes on Blast-Furnace Filling" by Mr. D. E. Roberts, (Cardiff) was devoted mainly to a general comparison of the two principal types of mechanical equipment for charging blast-furnaces, the skip type and the bucket type. Eighteen figures and a photograph of different mechanical charging systems at work, or proposed, in the U. S. A., Great Britain, and on the continent of Europe serve to illustrate the paper. The author emphasizes "that the question of good distribution is a most vital matter in a blast-furnace, and any reasonable outlay is justified in obtaining it." For that reason he favors the bucket design.

British Siemens Furnace Practice

"British Siemens Furnace Practice" by Mr. Fred Clements, (Rotherham) is an exhaestive analysis of the thermal efficiency of a 60-ton Siemens furnace making basic steel at the Park Gate Works near Rotherham, England. The paper is accompanied by no less than fourteen large sheets giving details of chemical and thermal balance sheets, furnace designs, temperature graphs, fuel and air consumptions, data of furnace charges, etc., etc.

Regarding the heat balance the author says, "there are two facts which deserve special remark:

(1). "The thermal benefit of charging hot mixer metal, as distinct from the undoubted chemical advantage, beomes very apparent as the metal brings in 19.2 x10⁶ C. H. U., which is 40.5 per cent. of the total shown, and it can be taken that a larger proportion of heat than this would be required to melt it were the metal charged cold.

(2). "The over-all thermal efficiency amounts to only 16.98 per cent. and, in view of the considerable heat loss which this indicates, it becomes of great importance to investigate the heat distribution throughout the furnace installation, and to examine whether any means of prevention or recovery can be adopted."

Mr. Clements gives the following figures as the distribution of the heat losses.

(A) Radiation from the bath and port ends 44.2 per cent.

(B). Radiation from the regenerators 15.5 per cent.

(C) Radiation from flues 4.1 per cent.

(D) Heat lost with the gases to the chimney 36.2 per cent.

The paper concludes with the consideration of the design of a furnace of 100 tons capacity, and the suggested arrangement of such a furnace is given.

Power Production

"Recent Developments in Power Production" was the title of a paper by Mr. D. L. Selby-Bigge, (London). This communication called attention to the fact that in Great Britian, coal remains the basic source from which the bulk of the power is derived. Attention was directed to the cleaning of low grade fuels by Froth Flotation processes; the increase in the size and capacity of water tube boilers; the increased working pressures of steam employed, mechanical stoking; the use of pulverised fuel; waste-heat boilers. The employment of powdered fuel for re-heating furnaces was also dealt with, and figures given showing the results obtained at the works of Messrs. Schneider et Cie. Creusot. Working on ingots and billets at the rate of 45 tons per 8 hours, the average of a six months' run including meal stoppages, Sundays, etc., was 176 lbs. of coal (22 per cent.ash) consumed per ton of metal heated from cold to rolling temperature.

Heat of Formation of Pearlite

Amongst the scientific papers presented, pearlite, as a constituent of steels or of iron-carbon alloys, received considerable attention. N. Yamada (Tohoku Imperial University, Japan.) gave the results of his investigations into the heat of transformation of austenite to martensite and of martensite to pearlite. The calorimeter used for the experiments was described, and with this instrument the heat of dissolution of carbon in iron was measured for six kinds of carbon steels: it was found to increase linearly with the content of carbon in steels, and to amount to 1130 calories per gramme of carbon. The heat of the allotropic transformation austentic-martensite is stated to increase linearly with carbon, and to amount to 5.6 calories per gramme for eutectoid steel. The specific heats of troostite, sorbite, and pearlite have the same value within the limit of experimental error.

A. F. Hallimond (London.) contributed a paper on "Delayed Crystallisation in the Carbon Steels: the Formation of Pearlite, Troostite, and Martensite," whilst J. H. Whitely (Stockton.) dealt with "The Formation of Globular Pearlite". As a result of his work, Mr. Whitely states that the carbide constitnent of pearlite does not at once dissolve completely at Ac1. With coarse-grained hypo-eutectoid steel, heating for more than 15 minutes is needed at 760 deg. C., 40 deg. C. above Ac1, to effect a complete solution, and much longer periods at lower temperatures. The persistence of the nuclei also depends to a large extent upon the size of the pearlite grain. Increase of the grain-size retards solution. On cooling, these residual nuclei, even if ultramicroscopic in size, inoculate the solid solution at the transition point, and the pearlite so formed is spheroidal and not lamellar in structure. Globular pearlite can be formed in hypo-eutectoid steel at a temperature 15 to 20 deg. C. higher than lamellar pearlite. It is suggested that, in hypo-eutectoid steels at any rate, the formation of lamellar pearlite only, during slow cooling, indicates the entire absence of carbide nuclei from the solid solution.

The Structures of Pearlite

Of much interest to metallographers was a paper by Colonel N. T. Belaiew (London) entitled "The Inner Structure of the Pearlite Grain". In this communication Col. Belaiew points out that in a grain of lamellar pearlite the arrangement of the cementite lamellae is roughly parallel to one another and to the crystallographic plane of the grain, presumably to one face of the cube. A secant plane perpendicular to that face will be found normal to the lamellae, and the angle of in-

clination for that plane will be zero. All the lamellae of the grain will be seen on the normal plane, and the distance between two lamellae on such a plane will be the actual distance. But, if the section of the grain of pearlite does not form a secant plane perpendicular to the face of the cube, then, as the angle of inclination increases, the number of lamellae seen on the section decreases, and the apparent distance between two lamellae increases. When the angle of inclination approaches 80 deg. the distance between the lamellae becomes five times greater than when the angle is 0 deg. ten times at 84 deg., and twenty times at 87 deg. The aspect of pearlite, as we are accustomed to see it, must exhibit a considerable change on some sections.

Some of the alloys which Colonel Belaiew examined during his work on this subject were made in Russia so long ago as 1915 under conditions of extremely slow cooling. The paper is illustrated with a series of beautiful photo-micrographs, many of them at the high magnifications of 3000 and 4000 diameters. One of these micrographs, "Steps of Pearlite", at a magnification of 4,500 diameters, is an especially fine example of metal microscopy.

New Light on the Process of Case-hardening

Amongst the papers presented was one which cannot fail to be of great interest to all who are interested in the process of case-hardening, or who are engaged in the manufacture of steel for this purpose. The paper was contributed by Mr. E. W. Ehn (Canton, Ohio, U. S. A.) under the title "Influence of Dissolved Oxides on Carburising Qualities of Steel." The paper deals mainly with straight low-carbon steel such as S. A. E. 1020 of the composition:

	Per Cent.
Carbon	0.15 to 0.20
Manganese	0.35 to 0.65
Phosphorus, below	0.04
Sulphur below	0.04
Silicon	0.005 to0.10

and at the commencement the author states "It is generally assumed that steels of similar chemical composition should respond similarly to case-hardening operations, and that if these be properly conducted satisfactory results should be obtained. The object of this paper is to show that this is far from true, and and that the presence in the steel of non-metallic impurities in solid solution, presumably oxides, due to improper deoxidation of the steel when made, affects permanently the carburising and hardening qualities of the steel." Mr. Ehn goes further than this, and says, "As a rough estimate, about 25 per cent. of all steel bought from outside sources has been found unsuitable for carburising, in spite of the fact that such steel was bought from some of the most reputable steelmakers in the country, and in accordance with commonly used specifications."

The paper classifies steels (which may be of exactly the same analysis) for case-hardening as "normal", "abnormal", and "intermediate". The normal steels are those which on carburising and hardening in water acquire a uniformly hard, martensitic case. The abnormal steels are those which when subjected to precisely the same treatment give soft spots in the case. Most case-hardening steels fall into the class of "intermediate".

The following table shows the difference between normal and abnormal steels:

	Normal Steel	Abnormal Steel
Depth of case and maximum carbon content.	Deeper, with less maximum carbon content than abnormal steel.	Thinner, with higher maximum carbon content than normal steel.
Core.	Large grain size. Angular outline of pearlitic areas.	Small grain size. Rounded outline of pearlitic areas.
Gradation zone.	Same.	Same.
Hyperentectoid zone.	Large grain size. Cementite at grain boundaries in network. Large solid areas of pearlite.	Small grain size. Cementite as curly fragments surrounded by ferrite formed by the more os less complete disintegration of the pearlite.

In the original paper the opinions expressed as to the cause of mysterious failures to obtain a uniformly hard product are supported by 32 photo-micrographs, and evidence is brought forward to prove that the characteristics of the abnormal steels are due to oxides in solid solution. As steels cannot be classified as normal or abnormal by the usual chemical or physical test methods, Mr. Ehn recommends, in order to avoid failures due to the use of abnormal steels, that specimens of all steel supplied for case-hardening be subjected to a carburising test, and that miscroscopical examination of the carburised sections be made. He is also inclined to recommend for general carburising purposes a steel containing 0.30 to 0.50 per cent. chromium, as it is very unusual to find a chromium steel with abnormal properties. Finally, attention is called to the fact that the influence of oxides in steel is not restricted to carburised low-carbon steel only, and it is suggested that perhaps even the mysterious property of steel known as "body" may ultimately be explained by the presence or absence in the steel of non-metallic impurities, presumably oxides in solid colloidal solution. The entire paper is well worth the careful study of all who are interested either as users or producers of case-hardening steels. As a result of practical experiences extending over several years the present writer finds himself in agreement with many of the statements in this paper by Mr. Ehn, and considers that it throws a new light upon some of the hitherto obscure phases of the process of case-hardening.

The Canadian production of chromite, which reached considerable proportions under the stimulus of war-time prices, has now declined to zero. The deposits of ore are still available in case of emergency; but the ore at present discovered is not rich enough to compete with the South African ore in the open market.

DR. RUTTAN URGES RESEARCH GUILDS

by Alexander Gray

For reasons that need not be stated Dr. R. F. Ruttan as a pre-eminent Scientist is in a position to stand four-square when he addresses his fellows of the international British Society of Chemical Industry, of which he is President. It is the more appropriate to have a man of his achievements and independence make the retort courteous to legislative ostriches who seem to think Canada can keep on importing what she is able to produce, and exporting technical experts, graduates of her own universities, and retain those who remain upon a beggarly stipend. With about 4,000 engineers somewhere near the bread line (most of them qualified by Canadian collegiate training and experience) Dr. Ruttan made a patriotic appeal to the Canadian Branch of the Society of Chemical Industry for a higher valuation, a greater degree of public recognition of the services of Canadian Chemists. They had demonstrated their resourcefulness and economic worth prior to and during the War and their value can be enhanced in time of Peace and greater Competition. "More than a thousand of the best graduates of Canadian Universities have emigrated to the United States" urged Dr Ruttan, "whose industries and wealth they are developing", and if Research Guilds are provided "with simply-equipped laboratories, each costing $25,000, and sufficient salaries, it is hoped some of these brilliant men will return."

The plan advanced by Dr Ruttan is that Guilds similar to the resarch associations recently formed in Britain be formed from groups of industries interested in the same line of research. By this plan, and through research, he said, much can be done to liquidate the national debt.

One serious difficulty is the low standard of value maintained at Ottawa and elsewhere. Individual initiative will go so far; collective, group effort through Guilds is a practical solution. It is being proved so in the United States, not only in chemical research but wherever mechanics enter into industrial affairs. Leaders of industry have liberally subscribed funds. Inventors have the privilege of submitting their devices or formulas, duly patented or meriting consideration. Specialists pass upon the features of whatever looks like an added efficiency or an economy in any direction.

Ordinarily inventive genuises fear sharp practice and decline to deal with principals who might regard really meritorious inventions as being inimical to their vested interests. The contrary is the declared purpose of those responsible for this central organization, to which money is devoted because progressive economies must be effected. Suppression is not contemplated. Whatever is better than anything Gary and Schwab now posses, is worth more to them, it is reasoned, than it could be to others. If there is something the General Electric and Westinghouse people need in order to increase production by simpler methods, the argument is that those great corporations will pay more for it, knowing what it promises.

Dr. Ruttan has the right to call for Government aid—more aid than has ever been provided. Speaking to and for the Chemical Industry he exercised that right. At no time has there been greater necessity for exactly what is sought—the encouragement and retention of our Canadian-made Scientists.

TAYLOR INSTRUMENT COMPANIES IN TORONTO

The following letter to "Iron and Steel of Canada" from the Taylor Instrument Companies, Rochester, N. Y. is self-explanatory.

"The publication of a news dispatch in the Canadian press of the purchase by Taylor Instrument Companies of the Stevenson Building, Toronto, has made current many rumors which, harmless in themselves, might create false impressions. Accordingly, we give certain facts below, in the belief that a news item in your publication based therenpon, would give the exact situation existent today.

"A—We have just completed the purchase of the property at 110-112 Church Street, corner Lombard Street, Toronto, which has been known as the "Stevenson" Building, and which will now be called the "TYCOS" Building.

"B—The size of our plant will come about simply from a slow development.

"C—We will start in the repairing of all of the various instruments manufactured by us, and to begin with assemble certain instruments, and the extent to which we will manufacture or assemble in Canada will depend entirely epon the demand for the product.

"D—We have already started in repair and certain assembling work.

"E—It is impossible to say how many hands are likely to be employed, as this will be a development in proportion to the Canadian possibilities in our line."

BRITISH ELECTRIC STEEL INDUSTRY

Valuable data concerning the present status of the electric steel industry of Great Britain are contained in a recent pamphlet on the "Steel-Making Facilities of Great Britain," written by H. B. Allin Smith of the Bureau of Foreign and Domestic Commerce, Washington. The following table gives the number and size of such furnaces at the beginning of 1922:

Unit Capacity	No. of Furnaces	Capacity per Charge
5 hundredweight	1	0.25
6 hundredweight	1	0.30
½ ton	15	7.50
18 hundredweight	2	1.80
1 ton	5	5.00
1¼ tons	1	1.25
1½ tons	19	28.50
2 tons	20	40.00
2½ tons	3	7.50
3 tons	18	54.00
3½ tons	6	21.00
4 tons	5	20.00
5 tons	3	15.00
6 tons	11	66.00
7 tons	10	70.00
7½ tons	2	15.00
10 tons	8	80.00
15 tons	2	30.00
20 tons	1	20.00
Miscellaneous (estimated at 1½ tons)	15	22.50
Total	148	505.60

Records show that 16 firms had about 21 electric furnaces in their equipment during 1914, and this score of furnaces ranged within the narrow limits of 1 to 3½ tons per charge. In 1922 there are nearly 150 installations with a range from 5 hundredweight to 20 tons per charge, the majority holding around 2 tons, but 60 or more of them being in the 3-ton class and larger.

Electric Tool-Steel

A Paper, entitled "The Present and Future Scope of the Electric Furnace in the manufacture of Tool-Steel," was read by Mr. F. Rowlinson, at a meeting of the West Yorkshire Metallurgical Society held at Leeds on April 1. The author, in discussing the selection of materials to be melted in the production of tool-steel, the melting practice employed, and the inherent limitations and characteristics imposed by the furnace and melting apparatus, remarked that the crucible steel industry was nearly two hundred years old, and it was noteworthy that during the whole period an outstanding feature of the crucible trade had been the great care and discrimination used in the selection of materials for melting. The old crucible-steel makers were under no delusions on the point. Chemical refining never troubled them; they knew that when quality went in, quality came out; and so they chose their materials from the best in the world, the best steel-making Swedish irons, the best Sheffield blister bar, every piece hand-fractured and graded, the best Swedish white irons, and the best Sheffield tool scrap. All these materials, of unsurpassed purity and quality, were chosen, and no others. The best crucible steel to-day was still made from the materials chosen more than a hundred years ago. The crucible-steel industry had been called conservative, apathetic, but the fact still remained that to this day the finest tool steel in the world, Sheffield's crucible steel, was made only from the most expensive materials of unquestioned purity and quality. Chemical guidance was absent when tool-steel first began to be manufactured, and but little was needed to-day. Where no impurities went in, no chemical means were necessary to take them out again.

From time to time various process had aspired to displace the crucible by substituting inferior materials and refining them to give a high-grade product. Bessemer and open-hearth steel were used in Sheffield, but the product was distinctly third grade.

Electric tool-steel melters had endeavoured to reduce the expense of selected high-grade materials by refining in the electric furnace material of only moderate purity, and they had produced a steel which, in analysis and appearance, was exactly equivalent to the best crucible steel; but trial soon showed that it was deficient in quality, and it lacked that indefinable "body" possessed by a high-class crucible steel. The claims that the electric furnace could be charged with any old scrap, provided it was steel, and that by clever chemical manipulation and elaborate refining a tool-steel of the finest quality could be produced, had done incalculable harm. Electric tool-steel makers were realising every day that the electric furnace must be regarded as an apparatus for melting only, if it is to produce a high-grade tool steel.

Various objections had been put that the high temperature of the arc in an electric furnace led to deterioration of the metal, but even expert opinion could give no adequate explanation of this. In any case the metal was protected by a good blanket of slag. The crucible furnace was completely sealed except when the lid was removed for pottering or additions. This led to a very slight oxidation of the charge, say three or four points of carbon. Exactly similar conditions applied to the electric furnace. This also could be completely sealed except for the necessary working; a slight initial oxidation of about three points of carbon gave place to a reducing atmosphere far more intense than that of the crucible. In this respect conditions were similiar in both processes; in fact, the electric furnace should show a slight superiority, due to the better reducing conditions, the basic hearth and slag and sulphur.

Steel made to this schedule should be cast in top-cast ingots, wide-end up with a funnel runner, and a generous hot top or dozzle. Ingots should be as large as large as possible for the class of work for which they were required and should be reasonably uniform in size for any one plant.

Concluding, the author remarked that as no saving was permissible in materials charged or in care in operation, it was obvious that the electric furnace must seek to justify itself by economic advantages in other ways. This would be secured by handling high-grade steel in larger quantities by melting in hundredweights instead of pounds, by higher thermal efficiency. In general, economy must be sought by applying quantity methods and appliances to quality production. The furnace should be at least 30 cwts. capacity or 10 cwts. for high-speed and similar steels. The charge of selected materials should be heavy stock, of which 25 per cent. should be heavy first-grade tool-scrap. No ore additions, mill scale or other boiling agents must be permitted, and no slagging. Carburation should be by the finest carburising agents, no solid carbon or grey iron permitted. No ladle additions should be made except a little aluminium, and a white slag should be attained, and kept for at least an hour before tapping. Heats of the second or third-grade should be either discarded first quality heats, or heats with slightly inferior melting stock. Second-grades heats might be permitted a little refining, third-grade heats rather more with more latitude in the ladle additions.

LARGE HEROULT FURNACES

Acording to Mr. J. M. Hall, in electric furnace work the most striking development of the past year has been the successful starting up of the 40-ton Heroult electric furnaces in the U. S. Government armour-plate plant. These furances are round with a shell 18 feet in diameter and 8 feet high, with 18-inch brick walls. Three electrodes are used 24 inch in diameter for amorphous carbon, and 14 inch for graphite, which has been tried experimentally. The furnaces take hot metal from two basic open-hearth furnaces, in which the phosphorous is reduced to about 0.015 per cent.; in the electric furnace the metal is refined and the sulphur brought down to between 0.008 and 0.015 per cent. The next step will be to a much larger furnace; the 100-ton electric furnace is in sight.

Production in Iron and Steel Centres

SWEDISH IRON AND STEEL

According to the quarterly report of the Swedish Ironworks Association, the first quarter of 1922 has not brought any appreciable relief in the depressed condition of the iron an steel market. It must be admitted, however, that the export of certain classes of steel such as ingots, bars and wire rods, has improved, and that the total exports for the quarter exceed those of the first quarter in 1921 by about 3,900 tons. It should be noted, however, that in the statistics for this quarter are included 5,900 tons scrap derived from old stock, which should not be included in this year's production.

The Swedish engineering industry is still suffering from the universal depression, as proved by the fact that the imports of iron and steel during this quarter were reduced by 17,000 tons, and are now about 50 per cent. below the figures for the first quarter of 1921.

Orders from abroad continue to be scarce, although there is a somewhat increased demand for some special brands. The prices obtainable are, however, unsatisfactory, being considerably below the cost of production. Some big Government orders have lately been placed, but in spite of this fact the number of orders received is far from satisfactory, although certain indications point to an improvement in the last few months.

The following figures show the output of the various kinds of iron and steel in tons, in round figures, during the first quarter of 1922 (and 1921): —Pig-iron, including direct castings, 57,400 (103,700); blooms and puddled bars, 5,700 (6,600); Bessemer steel ingots, 7,900 (3,800); open-hearth steel ingots, 2,900 (3,500); rolled and forged finished iron and steel products, 39,900 (27,500).

JAPANESE IRON AND STEEL INDUSTRY

The output of iron and steel in Japan has fallen off considerably since 1919, and a further reduction is anticipated when armament limitation becomes effective. The Minister of Commerce informed the members of the Budget Committee of the House of Peers that the production of the Yawata Steel Works for 1919 amounted to 610,000 tons of pig-iron, and 550,000 tons of steel. In 1921 the output was 500,000 tons of pig iron and 530,000 tons of steel. The chief of the Yawata Works said that foreign iron and steel are imported and sold at lower prices than the Japanese makers can meet, and that the armament limitation would reduce the output of finished steel by about 60,000 tons annually. The Industrial Investigation Council has formulated three plans for the relief of the industry. The first is the amalgamation of the iron and steel industries; the second, tariff etaoi nne taoinhrdl uemfyp roinhrdlu hrd subsidies. The first plan is thought to be difficult of realisation owing toi the conflicting interests among makers, and the Industrial Council is now carrying on investigations in regard to the other two measures

IRON AND STEEL IN ITALY

At a conference of the principal Italian industrials, held in Rome for discussing the present acute crisis, it was pointed out that this was in a great measure accentuated by the continual interruptions in the traffic at the ports, the preference given by the Italian Government to German machinery and goods, the ill-advised fiscal, customs and financial measures, and the long delay in the solution of the crisis of the Banca Italiana di Sconto. A general closing down of works is threatened if something is not done promptly to relieve the situation.

The output of the Italian iron and steel industry during the past year included 25,400 tons of synthetic pig-iron, 26,900 tons of coke iron, 8,100 tons of charcoal iron, 683,200 tons of steel ingots and castings, 15,400 tons of ferro-alloys, 274,000 tons of iron ore, and 448,600 tons of pyrites.

PIG-IRON PRODUCTION OF SOUTH RUSSIA

A recent statement in the Soviet papers is to the effect that the output of pig-iron in Southern Russia in 1921 was only 119,670 tons as compared with 4,474,737 tons in 1913. This last figure, however, is incorrect, as Southern Russia alone produced only 3,046, 120 tons of pig-iron in 1913, the Urals coming next with 412,160 tons, and the Moscow district with 189,980 tons, leaving a small balance for Northern Russia to make up a total of 4,546, 607 tons in the whole of Russia.

FRENCH STEEL OUTPUT

According to the returns received by the French *Comité des Forges*, the total output of steel in France in 1921 was 3,102,170 tons, of which 3,005,454 tons were ingots and 96,176 tons castings. The total represents an increase of 915,910 tons on the 1919 figure and 51,774 tons on the total of 1920. The increase was in ingot production.

Of the 3,102,170 tons of steel output, 1,779,860 tons were basic Bessemer steel, 45, 094 tons were acid Bessemer steel, 1,243,216 tons open-hearth steel, 9,543 tons crucible steel, and 24,457 tons were produced in electric furnaces. Of the total, 66.1 per cent. were produced in the Eastern district and in Alsace-Lorraine against 59.4 per cent. in 1920.

The steel works consumed 18,579 tons of ore, 28,709 tons of acid Bessemer pig-iron, 2,035,047 tons of basic Bessemer pig-iron, 9,548 tons of low-mangenese pig-iron, 249,154 tons of forge pig-iron, 119,653 tons of special pig-iron, and 1,056,697 tons of scrap, etc.

The plant in 1921 included 40 acid converters, 54 basic converters, 90 open-hearth furnaces, 13 crucible and 13 electric furnaces. The number of workpeople in 1921 was about 71,000.

The total output of finished products in 1921 was 2,188,714 tons, of which 267,750 tons were rolled joists and other shapes, 292,946 tons rails, 292,154 tons plates and sheets, 74,687 tons universal flats, 759,014 tons bars and commercial steel, 18,004 tons were hoops, 48,208 tons tyres, 10,348 tons springs, 36,729 tons fishplates, sleepers and sole plates, 118,525 tons wire rods, 87,906 tons wire, 30,468 tons tubes, 78,345 tons castings, 40,579 tons forgings, 16,402 tons tinplates, and 17,249 tons were finished products of other descriptions.

The *Comité des Forges* report that on February 1 last, there were 196 blast furnaces in France, of which 66 were in blast, 74 were ready to be blown in, and 56 were reconstructing or being overhauled and repaired. By March 1 the number of blast furnaces was increased to 207, of which 76 were in blast and 72 were ready to be blown in. The French pig-iron output in February last was 323,093 tons, compared with 311,815 in January. The output of steel ingots and castings was 316,705 tons in February, as compared with 314,598 tons in January last.

Main Belting Company of Canada

The Main Belting Company of Canada Limited incorporated as a Canadian company in March 1910 with Mr. W. T. Plummer as President, W. McGeorge Vice President and Daniel E. Parker Treasurer and Managing Director.

During the last twelve years their sales of LEVIATHAN and ANACONDA Belting have increased to such an extent that they have found it necessary to equip a plant in Montreal for the manufacture of their belting in Canada. The same officers of the Company as at the original incorporation still remain in charge. The handling of their Canadian business always has been strictly Canadian and the decision to manufacture in Canada for domestic and export business is the result of plans made in their original entry into Canada.

Modern industry, because of its importance to mankind, the vastness of the field it covers, the infinite variety of its applications, the diversity of conditions under which these applications must be made and the ever changing nature of the conditions themselves, makes incessant and increasing demands upon the best that human intelligence can produce.

Innumerable problems have constantly to be solved, and none of them are more difficult and complex than those which arise in connection with belting. Without belting, industrial life, as it is to-day could not exist, for in the whole system of power transmission, nothing outranks belting in importance. It is thus evident that all questions regarding the selection and installation of belts require most careful consideration by trained experts.

Even in ordinary circumstances, where the difficulties to be encountered are chiefly mechanical, and where toughness and pliancy are the principal requisites of a good belt, there are many problems which require careful thought, but the difficulties to be overcome in such cases sink into insignificance compared with those encountered under the extraordinary conditions where belts often have to do their work.

Extremes of heat and cold, absolute absence of humidity, under-water conditions, fast and slow speeds, sudden increases and decreases of the "load"; all these have to be taken into consideration. In addition, the destructive effects of abrasion, acids, gases and chemical action have to be overcome. Hence it is evident that, if costly mistakes are to be avoided, a careful study of the conditions in each case is necessary before the belt is selected, and also no one belting will be able to give the same degree of efficiency on all the installations of all plants.

Leviathan-Anaconda belting is the result of an evolutionary process; it represents the prolonged labours of a host of expert chemists and engineers, and is a typical example of the survival of the fittest. In it are incorporated the results of many experiments and long practical experience in belt making.

It is the natural reply to the imperative demand for a belting of great strength and ruggedness, permanent pliancy and unfailing tractiveness, that can be depended upon to do its work satisfactorily, no matter what the conditions may be. Leviathan satisfies the demand where the question is one of mehanical difficulty, while Anaconda will give equal satisfaction where the conditions are abnormal.

The stretching of belting in service is one of the most troublesome things with which the user has to contend. Each Leviathan-Anaconda belt is stretched, in the Company's factory, in exact and definite proportion to its strength and the load it is intended to carry; it is likewise thoroughly ripened and matured. Hence it follows that these belts, when installed, possess the ability to deliver that load with a good margin of safety, under every possible working condition. "stretch," with its destructive twin "slip," has been practically eliminated.

Either Leviathan or Anaconda belts can be made endless if desired. After making, they are seasoned under tension so that the belt is just the right length and does not have to be altered after running a few months. Leviathan belting can be used anywhere and for any purpose, that ordinary belting is adapted to, with perfect satisfaction. There are certain special locations, however, where, on account of high temperatures, acids, fumes, etc., it would not be advisable to use Leviathan belting. For work of this nature, the Anaconda belt has been perfected. It is made on exactly similar lines to the Leviathan, but is processed so that it will withstand those extreme conditions under which it will have to do its work.

Plant of Main Belting Co. of Canada.

Properties of Stainless Steel*

The subject of stainless steel, with particular reference to the applicability of the material in colliery engineering, was brought before a meeting of the Midland Institute of Mining Engineers at Barnsley by Dr. W. H. Hatfield (Brown-Firth Research Laboratories, Sheffield).

The speaker said that the development of the chrome steels as rust-resisting steels was quite recent, and the subject was one which, at the present time, was undergoing rapid development. The application of such materials by mining engineers in the various mechanical devices utilised in mining was naturally the care of the specialist. Each application of a new material to a specific purpose required special consideration.

Stainless steel was the name applied to a range of steels which belong to the iron-carbon-chromium alloys, the chromium in all of them ranging from 12 to 14.5 per cent. The percentage of carbon, manganese, silicon and other elements was controlled within desirable limits. As a result of research and works experiment, there were now available other stainless steels than the original one which was produced for cutlery and allied purposes, and which were only rustless in the hard condition. The material was now supplied in a high-tensile and machinable condition, simply required machining to shape, and was satisfactorily rust-resisting without further treatment. There was also a malleable stainless steel which had been evolved for the purpose of supplying a rust-resisting material chiefly in sheet form, which could be easily deformed cold, hammered, pressed, or drawn into the requisite shape, and only required polishing to produce a good surface. There was also the so-called stainless iron, which was a stainless steel in which the carbon content was reduced to a very low percentage. All these steels were manufactured by the electric process of steel manufacture, and required and received the careful subsequent manufacture which was necessary in the case of alloy steels.

Continuing, the speaker said the strength of stainless steel, as determined on the tensile testing machine, varied from over 100 tons per square in. breaking load in the hard condition, down to 30 to 40 tons per square in. when fully tempered. The lower figure corresponded to malleable stainless steel or stainless iron. A specimen series of figures obtained with a steel containing 0.30 per cent. of carbon, the test pieces being oil-quenched from 950° C. (1,742° Fah.) and then tempered, showed that the hardness and tensile strength were substantially maintained up to a tempering temperature of 500 deg. C. (932 deg. Fah.); higher tempering temperatures then resulted in a thorough tempering of the material down to very low tensile figures. Results obtained from the Izod impact test showed that as the material was softer, the impact value went up to a very high figure. Apart from the malleable form, stainless steel was almost invariably either used in the hardened and slightly tempered condition in which it had a tensile strength of about 100 tons per sq. in., or it was used in the well-tempered condition, when it had a tensile strength of about 50 tons.

Exhaustive fatigue tests had also been carried out on this steel in both these condtions, with the following interesting results. The tests were performed on the Wohler rotary fatigue testing machine. The test piece was rotated horizontally at 1,500 r.p.m., with a load hung from one end. This load was changed for each test until a load was reached which just produced the stressing which the material would bear without rupture during 10 million revolutions. The results of the tests on stainless steel, in comparison with those obtained from an ordinary structural carbon steel, showed that mild steel could only be stressed alternately in tension and compression to between 11 and 12 tons per sq. in. if the material was to survive 10 million revolutions. In the 50-ton (well-tempered) condition, stainless steel would carry alternate tension and compression stresses of 21 tons per sq. in., whilst in the 100-ton (knife-temper) condition, this material would stand 32 tons per sq. in.

Stainless steel maintained its strength at high temperatures to a much greater degree than ordinary steel, and might therefore be employed with advantage where parts had to withstand stresses at temperatures above the normal. Moreover, experiments indicated that the energy absorbed in the notched-bar impact test was not substantially modified until temperatures approaching 600 deg. C. were attained. Above that temperature the values increased.

Regarding the resistance to scaling, Dr. Hatfield said that in comparison with ordinary carbon steels, stainless steel resisted scaling to a marked degree with increaing temperature. Tests performed up to 1,000 deg. C. (1,832 deg. Fah.) on mild steel, alloy steels, tungsten steels, and stainless steel, showed that stainless steel scaled less than any of the others. The temper colours produced at much lower temperatures formed an analogous phenomenon to scaling, and it was well known that when hardened tool-steel was tempered, the originally bright surface went through a series of colours. During that process of colour-change with increasing temperature, the skin of the steel became seriously affected when visible red heat was attained. Stainless steel responded in a very different manner, and up to temperatures of 800 deg. C. (1,472 deg. Fah.) the effect on the surface was confined to the colour effect only. The same temper colours obtained during tempering, in the case of stainless steel, corresponded to much higher temperatures than in the case of carbon steel.

The ordinary methods of preparing steel surfaces should be employed with stainless steel. It should be pointed out, however, that grinding should always be done with water. If by an abrading action the temperature of the surface was unduly raised, the stainless properties were locally affected by the scorching effect thus produced. For the best results the surface should always be as good as could be commercially obtained. Nevertheless, it was not necessary to have a highly-polished surface for the material to be rust-resisting, provided all scale and pit-marks were eliminated.

Concluding, the speaker said it was quite clear that there were about a colliery many items which could usefully and economically be manufactured in stainless steel; for instance, boiler fittings, pump rods, pump cylinder liners, ropes, etc.

The production of chromite in Southern Rhodesia has become one of the principal branches of the mineral industry of that part of South Africa. Last year's output had a value of almost a million dollars. There are also extensive deposits of chromite in the Transvaal; but those of Rhodesia promise to dominate the market.

Chromite is of interest to the ferrous metallurgist chiefly on account of the growing production of alloys of iron and chromium, such as "stainless steel", "stainless iron", and certain high-speed steels. Chromium and cobalt are the principal constituents of "stellite".

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* From Foundry Trade Journal.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

ELECTRIC STEEL

In a paper on "The Present Status of Electric Furnaces in Steel Making", read by Mr. H. Etchells, B.A., before the West of Scotland Iron and Steel Institute, and published in the "Journal" of the Institute, the author remarked that opinion was unanimous that properly-made electric steel gave shock-resistance tests, as exemplified by the Izod test, which were never approached by other classes of steel. Taking the same chemical composition of open-hearth and electric steels, the treatment being the same, the electric steel would give a better elongation, while its tensile strength remained about the same. In steel made for castings, these features came out remarkably well. Test-bars cut from a casting of basic open-hearth steel, C 0.25, Si 0.23, S 0.038, P 0.019, and Mn 0.63, without heat treatment, gave yield point, 15 tons; max. stress, 31 tons; elongation in 2 in., 16 per cent; reduction of area, 57 per cent. A comparable acid open-hearth steel of C 0.27, Si 0.27, S 0.04, P 0.29, Mn 0.57 gave yield point, 16 tons; max. stress, 31 tons; elongation, 13.5 per cent. on 2 in.; reduction of area, 53 per cent. A representative electric steel of C 0.24, Si 0.25, S 0.015, P 0.02, Mn 0.80 would give under the same conditions yield point, 18 tons; max. stress, 32 tons; elongation, 24 per cent. on 2 in.; reduction of area, 45 per cent. A plain carbon steel, C 0.35, gave on the rolled bar, without subsequent heat treatment, yield point, 33 tons; max. stress, 43.5; elongation, 24 per cent. on 2in.; reduction of area, 53.6; with an Izod test of 57 ft.-lbs. In working an electric furnace the slag should be kept as basic as possible, consistent with fluidity, and should never be allowed to become silicious. A good analysis was: CaO, 45 per cent.; SiO_2 10 per cent.; MnO, 7.00 per cent.; FeO, 28 per cent.; Fe_2O_3, 6 per cent.; P_2O_5, 1.50 per cent. A good finishing slag might contain 65 to 80 per cent. combined lime and magnesia, 15 to 25 p. c. silica, 4 to 6 per cent. alumina, traces only of maganese and iron oxides, and over 1 per cent. of sulphur.

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*GREY CAST IRON, MALLEABLE CAST IRON OR STEEL**

By Neville Deane.

The question as to which of these three materials to use is one which engineers are often called upon to solve in the designing of a new plant. Obviously, the answer is whichever of the three will perform the work required at the lowest cost, so that it is necessary to know for what purpose each material is most suitable.

Grey Iron

There are some uses which are almost exclusive to certain materials; others depend upon special circumstances. Grey iron castings are suitable for any parts subjected to a crushing strain, but not for parts intended to withstand twisting, bending, or shearing stresses. In fact, grey iron is for rigid structures, except under special conditions — e. g., piston rings. Such parts as furnace plates, engine bed-plate, columns, cylinders, pipes for gas and water, etc., are usually made of ordinary grey iron with success.

Malleable Iron

Malleable cast iron is, of course, more expensive than grey iron but, by way of compensation, sections may be made much lighter by reason of the increased strength, which is often more economical. Malleable castings are excellent for small to medium-sized work which is often called upon to bear bending or twisting stresses or to withstand shocks. For these reasons it is used, almost to the exclusion of other materials, for various parts of motors, cycles, agriculture machinery, railway work, keys, and a host of similar small parts. It is easily machined, can be cast into most intricate shapes of thick or thin sections, has a clean surface, can be bent in the cold if fairly thin, and has a remarkable power of resisting corrosion. These advantages are applicable to both white and black heart castings, but the former is more suitable for thin sections than thick, whilst the latter is suitable for either thick or thin sections.

Steel

With steel there is a choice between castings and forgings. Where possible the latter are the better, and in cases where strength is the main consideration, are to be preferred to malleable castings. On the other hand, steel castings are applicable to more complicated jobs where strength, together with ductility, is desired. Steel cannot easily be cast into very thin sections, such as is possible with malleable cast iron, and the surface is usually rougher.

There is also a tendency to blowholes and spongy defects unless care is taken. Additionally there is the "drawing" trouble characteristic of all castings. The strength is normally higher than that of malleable cast iron, and in addition the structure is the same throughout, whilst in malleable castings the inner core of the section is vastly different from the outer surface. This is a matter needing consideration if a large amount of machining is to be done.

To sum up, therefore, steel is used where strength and ductility are required more than anything else; malleable cast iron is used where strength and ductility combind with thin sections and clean-surfaced castings are needed; and grey cast iron is used where strength in compression, combined with a cast shape, but practically no malleability is reouired.

* From Foundry Trade Journal

BELGIAN STEELWORKS AND FOREIGN CONTRACTS

The recent success of Belgian steel works in securing contracts in international competition has reduced a Brussels paper to compile from official sources a list of such orders booked during the current year, with special reference to German competition. Taking the Belgian contract prices at 100, the percentages of the German prices are said to compare as follows:—An order for 21,000 tons of rails for Holland, 101; 1,2-50 tons of rails for Brazil, 101; other railway material for Brazil, 105. In the case of contracts for Bulgaria: —5,800 tons of rails, 114; 1,600 tyres,131; 101 tons of rail fastenings, 110; galvanised tubes, 125; and 50,000 steel sleepers, 116.

The results of the Belgian tenders for Bulgaria gave rise to the following comments on the part of a Sofia journal in February. Dealing with the rail contract it stated:—"Among the 14 firms who took part in this competition the Krupps firm offered a price of 4,000,-000 levas (say £160,000 at par) in excess of that of the Belgian syndicate. The whole amount involved was 28,000 000 levas (£1,120,000 at par). This competition, as well as the others which have recently taken place, has raised great interest on the part of our merchants in Belgian goods, the price of which has become the lowest in the European market."

-:- EDITORIAL -:-

CONFERENCE ON IRON ORE

The conference on iron ore called by the Honourable Harry Mills, Minister of Mines, in Toronto on July 5th, promises to mark an epoch in Ontario's, and Canada's, iron ore problem. Ever since Mr. Mills assumed his ministerial duties, he has evinced a special interest in this, the most serious single problem that confronts his department, as well as one of the most serious commercial problems that faces Canada. There is no need of repeating here the data that demonstrate the vast annual loss in the nation's revenue due to our present non-production of iron ore; but we wish to draw attention again to the fact that the problem that Mr. Mills is now facing squarely is one worthy of the best attention he can give it, and likewise that he will need, to attain its solution, the energetic assistance of some of the best brains in our country.

That Mr. Mills is fully cognisant of the fact that voluntary effort alone will never solve the problem, is demonstrated by his having at once acceded to and seconded the request of the conference that complete data, and well-considered recommendations therefrom, be gathered by a small commission of experts, the ablest that can be found, under a retainer from the Provincial government. Many have been the conferences on the question of Ontario's iron ore; but the resolutions adopted have in the main been empty verbiage, due to a lack of that concentrated and continuous human effort which alone is competent to solve the problem, and which is ordinarily not available unless it is adequately paid for.

For the first time (so far as we can learn) a prominent blast-furnace manager is numbered among the practical optimists who for years have believed that the iron ore to be had in Ontario can be economically used. It is mainly due to this accession to the ranks of the believers that the conference was able to present a united front in recommending that the provincial government appropriate public funds to investigate the problem. Mr. J. D. Jones, manager of the Algoma Steel Corporation, is not only a technologist of outstanding ability, but also a hard-headed business man. When, with his knowledge of the practical difficulties, he is willing to put himself publicly on record as in favour of an attempt to produce beneficiated ores in large quantity in Ontario, furnace managers with less practical knowledge and lacking his courageous pre-vision may well re-examine the situation.

This conference has been a demonstration of what can be accomplished when a keen mentality is applied with singleness of purpose to the solution of a public problem. When Mr. Mills called this conference together he must have had some misgivings lest the divergent, and possibly the selfish, interests of those present would obscure the vision of what is their common aim. Personal and sectional interests were, of course, discussed and at times threatened to monopolize the attention of the meeting. But judicial statements by several of the members were so impressive and were such outstanding features that the Minister was able, without undue effort, to direct attention to the main issues.

Mr. Mills has put his hand to the plow, and he is making a straight furrow. He is not a man whose attention will be easily diverted from his purpose. He has sought and obtained a popular mandate, voiced by the most competent leaders he could find. We hope and believe that he will have, from now on, the united and continuous support of those interested in Ontario's iron ore problem, and we are confident that this united effort will end in success.

CANADA'S BIRTHDAY

Last Saturday we celebrated our Dominion's fifty-fifth birthday. There are many now living who can remember the first Confederation day, when the unconnected British colonies of North America promised solemnly to become a unit within the British Empire. These fifty-five years have wrought a change that is beyond the vision even of those men of steadfast faith to whom the Act of Confederation was due. East and West have been brought together across a distance greater than ocean's width, and the barren plain between has become one of the world's granaries. The word *Canada* has come to signify, not merely a half of the North American continent, but the home of a young nation, as yet only partly conscious, elementary in its ideas, and unformed in its habits; but still (thanks to the late war) anxious and able to take its place among the nations. During these fifty-five years our iron and steel industry has grown from a mere beginning in 1867, and to-day is the principal item in our country's industrial system.

These are a few of the great things accomplished during the past half-century — mainly, be it noted, by the generation that is now handing over its burden to its successor. But not all the developments of that period offer us the same reasons for self-congratulation. It is well to look at both sides of the picture.

Though we have now a budding national consciousness, we must not forget that its growth is as yet not at all

robust, and its full bloom and fruition will be assured only if we tend and nurture it as its value deserves. The national interest is still subordinated, in large degree, to provincial and sectional interests; while personal interests at present exclude a view of the common weal to an extent that alarms many students of Canadian men and affairs. This immersion in our personal affairs, to the virtual exclusion of public duties, is so prevalent in Canada that our trans-Atlantic relatives commonly take it as typical of our country. The natural result is that Canada is today ruled to a great extent by demagogues and others of like tendency, whose interest is self-centred, to the exclusion of the interests that they publicly profess.

Nor are our habits unimpeachable in the sphere of social existence. Our chief city has lately earned the reputation of being the pest-house of the North American continent. The finger of scorn is being pointed at us by our southern neighbors with increasing regularity, and for just cause. Not until we make a united, national effort to control the illegal traffic in liquor and drugs, and other vicious tendencies for which our country is rapidly becoming notorious, can we consider ourselves on an equality with the citizens of the United States. They are at least making an honest attempt to "clean up" their country from coast to coast.

In the realm of finance, we have allowed, on a huge scale, a selfish manipulation of public and manufacturing services, of our natural resources and even of food-stuffs, that has made many millionaires, but has impoverished our country to a degree that we do not yet fully realize. Financial manipulators, still increasing in number, batten and grow fat on the bodies of those whose honest toil results in Canada's material well-being.

In our iron and steel industry we have much to be thankful for, yet much to fear. The whole of the iron ore feeding our furnaces is imported from abroad. This entails an annual expense of tremendous proportions. The efforts to date to develop a domestic source of supply have been, not fruitless, but inadequate. The most important single industry Canada possesses is on an insecure foundation. In this regard we Canadians have still to attain that position of independence and self-reliance which alone will make us worthy of nationhood.

We have here presented, deliberately, the sombre side of the question, as an antidote to the self-satisfaction and self-congratulation that usually accompany and succeed the national birthday. If we are to have an ordered and logical development in Canada, in mining as in other departments of our national life, we must face all sides of each question squarely.

FOUNDRYMEN PROMOTE INTERNATIONAL AMITY

The recent annual meeting of the American Foundrymen's Association in Rochester, N.Y., has more significance than most annual meetings. It was an international conference, as Canadian and British foundrymen had been especially invited to be present, and representatives of France and Belgium also attended.

It is now commonly realized that science is one and indivisible, and has no regard for inventions of man such as international boundaries. Science is one of those tangible assets to international co-operation and good-will that already ignores the man-made differences between nations and races—differences that have been so prolific of strife since that time in the dawn of history when the first martial genius invented organized human warfare. Organized warfare is not indigenous to the human race it was grafted upon it; and the consequent development of nationhood and international differences can be so modified by civilizing agencies as to cause a reversion to our former sound idea of primitive times, when the inevitable struggle for existence was not organized upon the artificial lines of international competition, but was based upon individual qualities, guided by natural impulses and instincts.

In bringing about the international amity that all but junkers and fire-brands desire, no means can be more effective than such co-operative activities as we have seen in operation in Rochester. The exchange of ideas among Americans, Canadians, Britishers, Frenchmen and Belgians will lead, not only to a better common understanding, and an exchange of scientific ideas, but to that every-day commercial intercourse upon which, it is said, the British Empire has been founded, and upon which it still so largely rests.

If the late war has resulted in no other good thing, it has produced an international acquaintance and interest that far transcends what previously existed. The barriers against international trade have lately been made higher, and still higher, but mainly, it may be noted, on the instigation of politicians and of commercial interests with selfish motives and a short-sighted policy. The sound and far-reaching policy, best in the long room for the whole world as well as far each of its component parts, is as free an intercourse among the nations as well-founded national policies and personal interests of the less selfish variety will allow. The foundrymen of five countries have begun to do their bit in bringing about this much-desired condition.

UNFINISHED PRODUCTS

In the metallurgical industries the term "finished product" is loosely used. We may take it to mean that, although smelter and refinery products may require further manufacture before they enter the markets of the world, they have been brought to the final stage so far as the prime producing establishments are concerned. For instance, concentrate, matte, impure bullion, or refined metal may be shipped and sold by a mining and smelting company. Only the refined metal, however, represents the "finished product".

There is something of an analogy here between the production of metals and the output of our universities. We fear that our institutions of learning are not yet giving us the properly finished articles. The substitute is often attractive, but it does not serve the purpose it is

supposed to serve. It is very apt to have its value diminished by "segregations," "slag inclusions and adhesions" and so on.

To be specific, there is not much evidence that our technical graduates are better fitted today to cope with the world, the flesh, and the devil, than they were twenty years ago. Today it is as true as it was a generation ago that a fairly bright young office man, without college training, has a vastly greater chance of becoming the general manager or president of a large mining or smelting company than has the technical graduate.

In part the "segregations" and "slag adhesions" mentioned above, impede the graduate's progress. He leaves college with pre-conceived ideas that it may take years of hard knocks to correct. In the three or four years of his college course he is taught nothing at all that touches directly on the making and handling of money. Even the marketing of mineral products is totally neglected. The results speak for themselves in no uncertain way. Unemployment or constant change of employment, no hope of a competency unless he permit the promoter to misuse him, these are the guerdon of the mining engineer. And yet our colleges continue cheerily to turn loose increasing numbers of mining graduates, to wander in the parched and perilous pastures of the business world!

BRITISH MONEY FOR BRITISH DOMINIONS

There has evidently been launched in London lately a well-organized and decided movement in favour of the development of the natural resources of the Empire. The slogan "Britons for British Dominions" is to be accompanied by "British money for British Dominions." One cable dispatch quotes *The Times* as saying that, since the Soviet has decided to remain apart from the world, British capital must look to the Empire for its opportunities of investment. Another announcement is to the effect that a group of prominent British manufacturers will enter seriously into supplying the Canadian trade, in competition with the United States, using Canada itself mainly as their base of operations.

All this, and much more that has transpired recently, speaks well for future Anglo-Canadian solidarity. A large part of the British investment in Canada to date has been of the long-distance variety, and consequently less of a cementing tie, and less satisfactory altogether, than the investment it is now proposed to make.

It is true that there will not be in Canada the opportunity for quick and easy gain that there might be in, say, Siberia. The British industrial pioneer in Siberia might have chances of development such as fall to the lot only of those that penetrate far among untutored peoples. In Canada the British investor will have to meet the competition of native Canadians and of our southern neighbors. Still, this will not by any means deter those who have for centuries got more than their quota of gain from the free markets of the world.

The chief undeveloped resource of Canada is her mineral deposits. It is fortunate for Canada that this is so. To quote Dr. C. V. Corless in his presidential address of last March, "Mining is the basic industry of progress, as agriculture is of subsistence." Except for unfortunate (though unavoidable) mishaps in the food supply of some parts of the world, and the present unbalanced state of war-torn Central Europe, the subsistence of the human race is pretty well provided for, and so the possibilities of the development of agriculture in Canada by means of the export of food-stuffs is limited.

Mineral production is in quite a different case. The consumption of the products of the world's mines has, through successive ages, measured roughly the attendant degree of civilization. Creature comfort and the leisure that is the pre-requisite of mental development are almost entirely dependent upon the products of mines and quarries. We are as yet far from the end of the advancement of our material civilization, and hence our consumption of mineral products will continue to increase vastly.

It is most desirable that the outside capital necessary to develop Canada's mineral industry should come, as much as possible, from Britain. We are now on the eve of developing what will probably be a most important industry—the production of iron ore. Our native ore is mainly of such a character that it requires concentration or "beneficiation" before it can be used in the blast-furnace. This treatment requires the establishment of extensive plants and a correspondingly heavy investment. It seems likely, at the moment, that the capital required will come mainly from the United States. We hope that at least a substantial part of the investment will be made by British capitalists. It is now rapidly becoming the vogue in Britain to develop Imperial rather than foreign resources. Here in Canada, to day, is an opportunity for British participation in a basic Canadian industry.

Inter-imperial relations have, since the commencement of the Great War, made most decided steps forward in various spheres. We are already commencing to reap benefits from this intercourse. By all means let us aid and encourage by every means in our power the development of Canadian mineral resources by means of British capital.

The National Research Council, Washington, has rendered yet another service to the technical public. It has just published a new edition of its pamphlet, "American Research Chemicals", in which are given thirty pages of chemicals used in laboratories, particularly research laboratories, and a list of eighty manufacturers in the United States from whom various specified chemicals can be obtained. As a large fraction of Canada's supply of pure chemicals comes from the United States, this bulletin (No. 35, May, 1922) will interest many researchers and laboratory workers here.

Notes From Nova Scotia

BY JOHN MOFFATT

Mines and Mills Busy Again

"Our Isle is full of noises, sounds and sweet airs, that give delight and hurt not". They are the noises of the mine, the workshop and the factory. The low hum of machinery, the whirr of rapidly revolving wheels, the pulsating of the great engines and the hearty voices of the workers all tell of new life throbbing through the veins and body of the two giant industries of Cape Breton — coal and steel.

Already coal is rising to a normal output and in a short time will exceed it. Collieries that have been dormant for over six months are now in operation, while a half-constructed colliery is again the scene of much activity. The word has been spoken and "every man is expected to do his duty."

It's "braw" to see the ships coming in for Cape Breton coal, great ten-thousand-ton cargo boats, taking away at one load three-fourths of a day's output. A short time ago fears were entertained in some quarters that the four hundred thousand tons of coal now in the stock piles might not be lifted this season and that a dull winter would naturally follow. But the steam shovels are busy, and we hope to see the coal heaps quickly transported to other quarters of the globe.

No. 24, the newest of the Dominion collieries, which was closed down early last December, is in operation again. This mine had just been put into condition to give a good output when depression struck the coal trade. Consequently none of its new equipment was put into motion. A new bank-head, with concrete decks, new tracks and tipples and screening machinery for assorting the coal, with new bank and haulage engines, have been awaiting the turning on of the power. The mine is equipped for an output of twelve hundred tons per day, but usually the calculation of tonnage is exceeded.

Miners Now Hard at Work

Mine labor is less restive and after the Award of two Conciliation Boards, it seems to have fallen into a more moderate mood. This may be due to the re-action after the prolonged efforts of agitators; but we are inclined to think that quiet reflection is settling down over the minds of men who were badly misguided and who are beginning to realize their best friends among the Executive Officers were those who counselled them against hasty action. Anyhow the workmen of Nova Scotia will think twice before again following a line of action that will still further lose them the sympathy and support of the public. The Executive Officers are giving little lead to the rank and file as to how they should vote on the Scott Award, and while it is desirable that the Award should be accepted, yet the greater injury will come to the workmen rather than to the Company from its non-acceptance.

President Baxter Vindicated

The vote on the recall of President Baxter was very small and therefore very disappointing to the Reds and their leaders. The only excuse that can be offered for such vile treatment of a faithful officer was the chagrin felt over the award of the Gillen Board, and the inflammatory speeches made by J. B. McLachlan. Men were "stirred to mutiny and rage". The Board, it was said "had failed to make full investigation", "the Coal Company were tyrannical" and "President Baxtor was a traitor," fit only to be cast out of society. Subjected to the "pelting of the most pitiless storms" of abuse, Bob Baxtor kept steadily on. This was base ingratitude to the men who had in the early days of the U. M. W. lead many a forlorn hope. Even his comrade in war, J. B. McLachlan, seemed anxious to follow the funeral car so long as he had full liberty to fire the funeral pile. Surely "judgment had fled to bruitish beasts and men had lost their reason." But President Baxter has been fully vindicated and to-day he stands higher than ever before in the eyes of the Canadian public, and of those who know him best.

Steel Plant Busy Again

The Sydney Steel Plant has two thousand men employed and rumors are rife that better things are in store for the immediate future. As it is, the number employed is a large addition to that of two months ago.

Inspection of B. E. Steel Plants

A number of Bethlehem steel experts and some New York financiers made a thorough inspection of the plants and property of the Empire Steel Corporation in Nova Scotia and elsewhere lately. Whether this means a new bond issue or a merger, is as yet an unanswered question. It is generally hoped that it will bring steady employment to the inactive steel plants of Nova Scotia.

Asked to Use More Coal

The Ottawa Government was petitioned by the Board of Trade and the Town Council of Sydney Mines, to buy and use more ceoal on the National railways, so that more employment might be given. Whether the Government will take any action in the matter remains to be seen, but at present a searching investigation is being made into the contracts of coal made for these railways during the Spring. The Nova Scotia members of parliament seem to be forcing the matter, and they are quite right.

Mooted Improvements in Steel Plant

Much is being written about improvement to the Sydney steel plant, and no doubt there is much to be done. A new blooming mill and fifteen new open-hearth furnaces are on the program. How soon work on these will begin is yet in the lap of the gods. The expenditure will be large, but it is understood that the saving per ton of steel will be such that on an annual output of one million tons per year the whole cost would not take many years to pay off. A number of the open hearth furnaces are ready to re-light, and gradually new departments are starting up, adding to the number of men employed.

Mr. Bischoff's Appointment

Mr. W. H. Bischoff is General Superintendent at the Sydney steel plant. He is well known to the men of the plant, and his is a most popular appointment. He is a big man with a smiling face, and has a kind word for all. When on his return he passed through the works, he had a real Highland welcome and was greeted on all sides by men of all departments. He had formerly served with the Company for over three years, and during that time he had made a host of friends.

Official Conference on Ontario Iron Ore

MEETING OF REPRESENTATIVE INTERESTS IN TORONTO ON JULY 5th.

When Ontario's present iron and steel industry was founded, twenty-five years ago, it was expected, and in fact assumed, that her iron ranges, known even then to be very large in extent, would furnish in abundance the hematite ore for which the blast-furnaces were built. The discovery of the famous Helen iron mine seemed to confirm this opinion. Prospectors swarmed over the iron ranges, scores of miles of them were taken up, and a good deal of capital was expended in acquiring property and in exploration. The main practical result was to prove the Helen ore-body to be unique, so far as exploration went. Another result was the disclosure of very large deposits of low-grade iron ore — the ore upon which our interest at present mainly hinges. So we have at present plenty of blast-furnaces and steel mills in Ontario, but no available ore, with the result that many attempts have been made to solve the problem of providing our own ore for our own furnaces. The problem is still unsolved.

With a view to securing the co-operation and advice of those interested in Ontario's iron ore problem, the Hon. Harry Mills, Minister of Mines for Ontario, held a conference in Toronto on July 5th, to which he invited representatives of the various interests concerned.. Between thirty and forty owners of iron ore deposits, blast-furnace operators, metallurgists, geologists, and representatives of the transportation companies assembled to aid Mr. Mills in devising ways and means of attacking the problem anew.

Agenda

To regulate the discussion and to give it a proper setting, a programme was arranged, and authorities on each subject were asked to prepare a presentation of that phase. The following are the agenda:—

(1) The extent of the iron ore deposits of Ontario. Are they sufficient to sustain a native blast furnace industry of importance?

(2) The kind and quality of the deposits:
- (a) The iron ores of Eastern Ontario.
- (b) Deposits of banded magnetic, or mixed magnetite and hematite
- (c) Siliceous hematite.
- (d) Siderites.
- (e) Bog iron ores.

(3)
- (a) The applicability of magnetic concentration methods for low grade magnetites, and subsequent briquetting or nodulising.
- (b) Processes for increasing the metallic content of siliceous hematites.
- (c) The reduction and nodulising of siderites.

(4) Are all or any of the above, or other methods of beneficiation within permissible limits of cost?

(5) How far can a market be found in Ontario for beneficiated Ontario ores?

(6) Is there a market for more than the present pig iron product of Ontario? If so, where?

(7) Can the problem be attacked by adapting a method of reduction to low grade ores, rather then by treating the ores so as to make them amenable to present blast furnace practice?

(8) Any aspects of the question not enumerated above.

This arrangement proved to be well-suited to the need. By means of it and by virtue of the adroit guidance of Mr. Mills, who is an unusually capable chairman, the effort of this gathering of men representing heterogeneous interests was made to focus on the aim common to all — the use of our own iron ores.

The Extent and Nature of Ontario's Iron Ore Deposits.

The discussion of the extent of the iron ore deposits so far discovered in Ontario was merged, naturally and perhaps inevitably, with the second question, their character. Mr. C. W. Knight, Assistant Provincial Geologist, led off with a clear and concise resumé of the geological conditions under which the various deposits have been formed, dwelling mainly on those differences in their character that are due to the geological age or epoch during which they had their origin. Mr. Knight also pointed out the well-marked differences between the productive ranges of Minnesota, Wisconsin and Michigan and the unproductive ones of Ontario — differences that were, in the main, overlooked by the earlier explorers and geologists, and that were forced upon their notice chiefly on account of the otherwise inexplicable lack of merchantable ore in Ontario. It is, by the way, this lack of discernment (or perhaps it might better be called prescience) that renders so many of the pronouncements of twenty years ago on our iron ranges, of little or no value today. Their similarity to the ranges of the United States was pointed out, but not the difference.

Dr. W. H. Collins, Director of the Geological Survey, Ottawa, followed with a comprehensive outline of the province's iron ranges, with especial reference to the kinds of ore-bearing material that they contain. Dr. Collins has during recent years spent several summers in the field studying the very problem; so his judgment is well-seasoned, and he speaks with more authority or the matter than is possible to any other geologist in the Dominion. Apart from the deposits of magnetic iron, which are of igneous origin, and are rather more widely scattered and of smaller size than similar ore-deposits in use elsewhere, our iron ore all occurs in sedimentary beds, now found mostly on edge. Thus we have, in the main, the tuncated edges of iron-bearing strata to explore. These beds of iron formation are of such a character as to be almost impervious to the circulation of surface waters; and this, in conjunction with their high angle of dip, militates against the enrichment that has produced the economic deposits of the United States. In certain cases the circumstances of our iron ranges are similar to the productive ranges of the United tates; and Dr. Collins is confident that extensive and systematic exploration with the diamond drill on those ranges will result in the discovery of similar ore-deposits.

In this connection there was a considerable amount of discussion with regard to specific iron ranges, presented mainly by those interested in them. Mr. T. B. Caldwell, of Perth, described the conditions that at present prevent the use of ore from the iron range at Temagami. Mr. Caldwell was, by the way, one of those who effectually aided the chairman in steering the conference clear of the rocks of dissention and the whirlpools of discussion that beset its course. Mr. Dreany, of Sault Ste. Marie, gave some details of the iron range in Michipicoten District in which he is interested, and a new nodulizing process now in course of development, which he expects to be successful. Mr. H. C. Cox, of Port Arthur, who has guided the course of the Moose Mountain experiment during its latter (and most successful) period, gave very interesting and impressive data about his deposits of ore. The vast bedded deposits of the Belcher Islands, low in phosphorus and sulphur, but

comparatively high in silica, were described, and their future use discussed.

Processes for Beneficiation.

To introduce the subject of beneficiation, Mr. Mills had asked Mr. G. C. MacKenzie, Secretary-Treasurer of the Canadian Institute of Mining and Metallurgy, to prepare a statement of what has been accomplished to date. Mr. MacKenzie's resumé was both lucid and comprehensive, and forestalled a great deal of discussion that might otherwise have consumed time with no good effect. Briefly, his conclusions are that the magnetic ore deposits of Eastern Ontario are too small and too widely scattered to stand the cost of concentration, and still compete with Lake Superior ores; that sintering is preferable to nodulizing in the agglomeration of fine magnetic concentrate; and that any process of beneficiation will succeed commercially only if operated on a very large scale.

In this connection both Mr. MacKenzie and Mr. Caldwell referred to the Eustis process for the "direct" production of steel from ore. Both had had a warm recommendation of the process from Mr. Bradley Stoughton, of New York, one of the foremost authorities on iron and steel on this continent. Mr. Stoughton considers that the electrolytic (as against the electrothermic) reduction of iron offers an opportunity of commercial application that is particularly suited to Central Canada, with her abundance of power and scarcity of carbonaceous reducing agents.

Mr. Cox described, in brief, the latest development in the production of sponge iron, as worked out recently by two young researchers of the United States Bureau of Mines. These results have not yet been made public; but Mr. Cox is hopeful that the new discoveries will go far toward bridging the gap that now separates the experimental work on sponge iron and its commercial application. He points out, what is of prime importance in Ontario, that the fine magnetic concentrate from our ore would form an ideal material for such a process and that the use of raw concentrate would cut out the present high cost of agglomeration for use in the blast-furnace. Mr. Cox also pointed out that the problem of producing merchantable ore at Moose Mountain has now, to all intents and purposes, been solved, and that what remains to be done is to establish such a connection with the users of ore as will warrant investment in a commercial plant.

The Cost of Beneficiation.

When it comes to a question of using ore, it is the furnace manager's dictum that rules. Consequently the account by Mr. J. D. Jones, manager of the Algoma Steel Corporation, of his recent investigations into the manufacture and use of beneficiated ores, and his conclusions, touched the heart of the discussion. The Algoma Steel Corporation has been foremost in Canada in making and using such ore, and Mr. Jones is in an exceptional position to judge of its commercial utility.

Some months ago Mr. Jones set out to determine at first hand what has been accomplished elsewhere on this continent in the concentration and agglomeration of lean ores. He visited a number of plants in the central and eastern United States, and his brief recital of what he saw was most informing. One important development that he noted is that the provision of high-grade concentrated ore from the low-grade material available along the Atlantic coast has now included Lake ore from that market and promises also to exclude the cheap ore of Cuba and Brazil. Mr. Jones' conclusion in regard to Canada—and this is worthy of more serious attention than any other utterance at the conference — is that suitable processes for benefeiation can and will provide Ontario ore for Ontario's furnaces, provided the problem is attached with energy and discretion.

The Market for Beneficiated Ores

At various times during the conference, the quality of benefeiated ores was discussed, and their suitability for use in the blast-furnace. The information elicited from those with direct evidence was that sinter, nodules or briquettes, properly made, are completely satisfactory, and a most desirable ore. Magpie Mine nodules are known to have a preferred market, due both to their useful form and their desirable chemical constitution. Sintered magnetic concentrate is now one of the standard varieties of iron ore. Grondal briquettes, such as are turned out by the Moose Mountain experimental plant, are less firmly established in the markets of this continent; but their desirability is undoubted. Mr. Cox told of having during the war time shipped his briquettes (almost pure iron oxide) as far south as Tennessee, at prices that were high even for boom times. There was a shipment made to a Canadian furnace that was composed of briquettes insufficiently bonded; but that was due to the irregularity to which all experimental work is subject, and from which no experimenter can escape.

Another point on which the majority of the members of the conference were clearly informed by the explanations of the furnace-men present, was the blending of ores required to produce the various qualities of iron wanted. This accurate blending necessitates, of course, an accurate knowledge of the chemical constitution of each kind of ore in stock, and pre-supposes uniformity throughout each of these stock-piles. The iron ore from all the mines of Lake region is now blended to produce certain standard mixtures, and the blast-furnace manager decides, months ahead, what proportion of each of these varieties of blended ore he will require for the coming year. The steel plant at Saut Ste. Marie may, for instance, require a million tons of ore of, say, four varieties, which, when blended in various proportions, will give foundry iron, basic iron, and the other varieties they will require during the ensuing year. It can be readily seen that to provide this million tons of ore, of the sorts required, from mines in Ontario, and to ensure a supply sufficient in quantity and uniform in quality, year after year, is rather a large undertaking, and will require not only a very large outlay of capital, but the application of the best brains that the province and the country can provide. But that the task can be accomplished, the sober judgment of Mr. Jones unequivocally affirms.

The Resolutions Adopted.

In order to induce an orderly consideration of resolutions, Mr. Mills suggested, quite early in the proceedings, the appointment of a resolutions committee, whose duty it would be to present the consensus of opinion in tabloid form at the end of the conference. When Mr. MacKenzie presented the resolutions that he, Mr. Caldewll and Mr. Cox had drawn up, they represented so well the principal ideas of the gathering that no change was necessary, and no discussion of consequence was provoked. The questions of the agenda were considered, seriatim, with the following result:

1.—The known and probable ore reserves now determined can provide sufficient beneficiated ore to sustain our blast furnaces; and it seems likely that intensive exploration will disclose commercial deposits of ore that will not require beneficiation.

2.—(Needs no answer).

3.—The present methods of beneficiation are satisfactory, and both nodulizing and briquetting (or sintering) are recommended.

4. and 5.—A conclusion on these questions is beyond the scope of the present conference, and they should be considered by a special committee or commission, the appointment of which by the Government the conference recom-

mends, the commission to be composed of a geologist, a blast furnace operator or metallurgist, and a representative of transportation interests.

It is this last recommendation that reaches the heart of the problem, as was immediately pointed out by Mr. Mills. The question of costs and of practical ways and means of applying the information now available constitutes the immediate problem, and this problem can be solved only by the intensive work of the best-informed authorities that can be had. In answer to a question, Mr. Mills, said that of course the services of these authorities would not be asked for without remuneration, and that he was confident that his colleagues of the provincial administration would provide adequate means for this purpose.

An additional resolution, not brought in by the resolutions committee, was on the much-debated question of a bonus for the production of iron ore. As drafted, this resolution requested aid from the public purse for the iron ore operator in Ontario, the manner of dispensing this aid being left open.

Vote of Thanks to the Minister.

After a day fruitful of well-informed discussion and resulting in a series of well-balanced resolutions, acceptable to all and particularly suited (as it turned out) to the prime mover of the conference, Mr. Caldwell tendered to the Hon. Mr. Mills the thanks of the meeting, not only for his initiative in calling the conference, but also for his care and discretion in guiding its destinies. Mr. Mills richly deserves all the credit that can be accorded him for this forward step in Ontario's iron ore problem.

THE SPECTROGRAPH FOR METALLURGICAL WORK

During recent years, developments in the appliances and technique of spectrographic work have been marked, and have now begun to make this branch of qualitative analysis available in a practical way. Messrs. Adam Hilger, Ltd., 75a Camden Road, London, N.W.I., have recently issued a series of catalogues and folders descriptive of the advances in the art of spectrography and its uses, and the appliances they are prepared to furnish. From one of these we gather the following data.

Spectra for the accurate determination, qualitatively, and the approximate estimation, quantitatively, of the ingredients of, say, a complex high-speed steel can now be readily made with spectrum apparatus. Arc spectra obtained through the agency of poles specially prepared to suit varying circumstances are recorded in photographs, and examined at leisure. The actual taking of the photograph can be accomplished by an intelligent assistant, and the chemist himself has now the means of readily interpreting the lines recorded on the spectrogram.

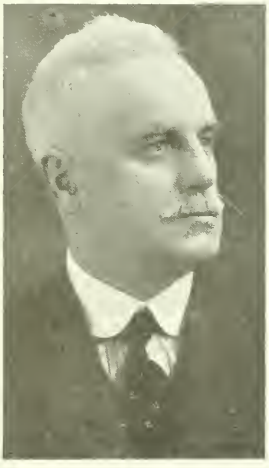
"To the analyst, the complete qualitative analysis of an unknown alloy, revealed by a spectrogram, is a sure basis for the planning of the most direct and rapid method of attack. As the determination of each element proceeds, the purity of precipitates may be checked as often as desired. The spectrograph proves invaluable in the recognition of impurities, the separation of which would involve a lengthy and difficult procedure, or when the weight of an unknown is less than is necessary to complete the desired determinations. A few hundredths of a gram will usually suffice for spectrographic analysis.

"Impurities in raw material are often a source of annyance, especially when their detection involves delay and costly analytical work. Whether low conductivity in copper is due to arsenic, nickel, or something else, may be quickly found out. Residual traces of boron, magnesium, manganese, silicon, vanadium and other deoxidising agents are easily identified where wet analysis may fail to reveal their presence, even after days of effort. Complex alloys of any kind are dissociated by the spectrograph into a spectrum, the reading of which gives the elements present, together with an idea of the relative amounts of each. The secrets of the inventors of alloys and hardened metals are no great problems when, for their solution, one can depend on the application of the microscope and the spectrograph."

This gives a suggestion of the rapidly expanding field in commercial as well as research work now open to spectrum analysis. The spectrum bids fair to become to the analyst what the X-ray is now to the surgeon and dentist. The progress of the spectrograph must be followed closely by those analysts and metallurgists that wish to keep abreast of the times.

A WELL-KNOWN EXECUTIVE

Mr. D. W. Clark, who has for years been managing director of the Canadian B. K. Motor Company, handling the tool steels of the parent firm in Sheffield, has recently changed the scene of his activities. He still remains in the steel trade, however, as he is now pres-



MR. D. W. CLARK

ident and general manager of the Anglo-Canadian Wire Rope Company, with headquarters in Montreal. Mr. Clark's activities in Canada have resulted in his being now well-known throughout the Dominion, particularly among iron and steel men.

Chain furnace screens for furnaces and ovens are becoming more and more used as their advantages are recognized. Primarily, this device was invented to protect workmen from the glare and heat to which they are subjected when charging the furnace or working the charge. Now it appears that there is a marked saving in heat as well, in addition to a modifying of the influx of cold air through the open door. The E. J. Codd Co., 700 South Caroline St., Baltimore, Md., have recently issued a pamphlet of eight pages describing their Wiegand patent chain furnace screens, which is available to those interested.

EFFICIENCY IN INDUSTRY

By A. R. R. JONES,
Editor "Journal of Commerce"

The revival of business should emphasize the need of individual efficiency in industry. Such is the view of Mr. S. W. Strauss, the president of the American Society for Thrift, and there will be few who are brought into constant contact with businesses, both large and small, and who have the opportunity of observing the waste which, in all too many instances, characterizes their operation, who will be disposed to quarrel with that view. Mr. Strauss goes on to say that, although American business is conducted with extreme aggressiveness and intelligence and the American business man is a dominant force in the affairs of mankind, there are glaring instances of waste in industry which should be an incentive to each of us to make every effort to increase the efficiency of our own work. We have little doubt that most of this applies with equal force to Canadian as to American business men and business methods.

Economy should conduce to the efficiency of an industrial or commercial organization as a whole. Reduction to a minimum of unnecessary expenses makes not for the diminished, but for the enhanced, efficiency of the organization. During the last year and more, practically every business enterprise in Canada has been endeavoring to reduce expenses. In some cases, the reductions have been accomplished in a manner which so far from impairing has actually increased the efficiency of the enterprise. But in many—far too many cases—the reductions have assumed one, or both, of two forms, either of which is extremely likely to turn out, in the future if not in the present, a bane instead of a boon to the enterprise which has succumbed to its temptation.

In the first place, in countless business enterprises the reductions have taken the form of a blind discharging of employees. Some concerns have even gone so far as to seriously compromise their future by discharging key men and leaders while retaining less experienced and less competent men solely because they were apparently cheaper. Sometimes this has not been the fault of the management, but the discharges were made in response to orders from a board of directors who could see only the pay roll and not the other side of the ledger. The pay roll can be seen, but often the methods of effecting real economies are "Out of sight and out of mind" and the future is left to take care of itself.

In the second place, there has been a determination on the part of many business concerns to attack their advertising appropriations with a hatchet, as it were, and practically regardless of consequences. At a time when orders need going after with all the vim and vigor available, concerns which act after this fashion are really — however those in control may seek to disguise the fact from themselves — letting up on their salesmanship. They have cut down on their advertising — their necessary and essential advertising — as they have discharged indispensable employees because such a mode of retrenchment, in each case, looked easy and likely to show immediate results. Such a policy is one of almost patently false economy. That it is one of false economy cannot be seriously doubted. Indeed, in all probability, nine out of every ten business men are ready to assent to the statement that advertising is an essential of present-day business, and even to the further statement that it is more essential when orders are hard than when they are easy to get. Yet so widely does practice often differ from theory that many a man who is ready to profess himself a firm believer in the uses of advertisement will be among the first to chop and lop his advertising appropriation until he makes it (and, in some cases, almost literally) look like thirty cents. Yet there is probably no concern so favorably placed that it can afford radically to cut down on advertising expenditures deliberately adopted. A sharp reduction in the advertising of nationally distributed articles, the reputations of which were apparently so firmly established that nothing could affect them adversely, has been followed by a heavy falling off in sales with the regularity of clockwork. To win a place in the crowded and besieged mind of the modern man is not equivalent to holding such a place. It is more like creating a melody which the prospect hears, enjoys, and inevitably forgets. It must be played and re-played, or other melodies will take its place. Not even the greatest corporation or the most popular product can hope to build up a reputation which will of its own force endure. The history of advertising is filled with striking proofs of human forgetfulness.

Yet the very concerns which show themselves the readiest to discharge indispensable employees and to effect the most drastic reductions in no less indispensable advertising are among the last to take account of those losses which are "Out of sight." The losses at many factories, for instance, which arise from starting work late—both in the morning and also after lunch—and stopping work early can easily run into very large figures. Then there are the delays between jobs, each perhaps small in itself, but large in the aggregate. In many factories, too, the belts, motors and other drives are given insufficient attention, and failures, causing losses of time, are numerous. Materials also furnish a fertile field for invisible losses which may arise from reduced prices, spoilage, poor design, theft, excessive cost, obsolesence, and too large a stock. The last item is an indirect loss, but may actually cripple a business by tying up capital. Then there are power losses due to transmission lines, shafting, belting, gears and pulleys; and still other losses due to poor combustion, improper

supply of air, poor grates, faulty furnace construction, extravagant use of fuel, steam leaks, uncovered steam pipes, waste of water and unnecessary burning of lights or the use of superfluous lights.

The foregoing are just a few samples of the "Out of sight" losses which occur in so large a number of factories, and nearly all of which can be enormously reduced.

For real, as distinguished from false, economy goes hand-in-hand with efficiency. Outside the industrial plant, as well as within it, losses to industry through individual negligence are of the most startling character. It is said, in regard to the waste in connection with the shipment of eggs, that not more than six eggs, out of every ten laid, ever reach the consumer. Less than one half of the trees cut from the forests reach the consumer. The waste in mining is of huge dimensions. So are the losses from fires that arise from avoidable causes. And so the tale goes on. Thriftlessness and slip-shod methods are among the greatest impediments to industry today in our own as in other lands. They can be eliminated, and they must be eliminated, if individual efficiency in industry is to be any more to us than a mere catchword

PRODUCTION OF IRON AND STEEL IN MAY

A report issued today by the Dominion Bureau of Statistics states the production of pig iron during May declined to the lowest level which has been reached in several years. The tonnage was 23,363, representing a decrease of 9,209 tons from April production. The record for the corresponding month last year was 56,091 tons. About 73 per cent. of the May production was foundry and malleable iron, intended for direct sale, while the remaining 27 per cent. chiefly basic iron was made for the use of the producing companies.

An interesting development was the increase in the output of ferro-alloys. The tonnage of 3,397 was the greatest since January, 1921, when 3,941 tons were reported. The output was augmented by the 2,499 tons of spiegeleisen manufactured for further use. The remainder, comprising 181 tons made in blast furnaces and 717 tons principally 75 per cent. and 80 per cent. ferro-silicon manufactured in electric furnaces was intended for direct sale.

Two blast furnaces at Sault Ste. Marie and one at Hamilton were operated during the month under review and the number of furnaces in blast remained unchanged.

The cumulative production if pig iron for the five months ending June 1, 1921, was 254,394 tons as compared with 163,424 tons during tahe corresponding period of the present year. This involves a decrease of 90,970 tons or nearly 36 per cent. On the other hand the output in the United States according to the "The Iron Age" increased from 8,363,333 tons during the first five months of 1921 to 9,689,653 tons in the corresponding period of 1922. The trend of Canadian pig iron has been declining since October, 1920 when the peak of 104,774 tons was reported. The steady increase of output in the United States since the beginning of the year may be taken as an index of improving business conditions in the iron and steel indestry, which in view of past experience may be expected in due course to extend to this country.

The production of steel during May registered a further decline of 4,935 tons below the April output of 21,935 tons. The May record of 17,000 tons comprising 15,646 tons of ingots and 1,354 tons of direct castings is the lowest in recent years. The 15,590 tons of open hearth basic ingots intended for use in the producing plants was 20,499 tons required for similar purpose.

The open-hearth basic and Bessemer castings intended chiefly for sale declined slightly from the output of April. The electric castings on the other hand presented an increase, the quantity intended for use by the establishments reporting was augmented from 53 to 503 tons.

The significance of recent declines in steel production is emphasized by comparing the cumulative record of 1921 with that of the present year. The total for the five months ending May 31st last was 144,275 tons while the output for the corresponding period in 1921 was 231,073 tons.

The production statement for the United States forms a sharp contrast with the statistics enumerated above. The enforced use of high priced coal due to the coal strike has caused a strengthening of prices. In spite of the uncertainty of marketing conditions due to the reduction in the freight rates which will be made effective shortly, the developments of recent months contain an element of encouragement.

COAL STATISTICS FOR MARCH

The *Coal Statistics for Canada, March,* 1922, are now available from the Dominion Bureau of Statistics, Ottawa. The total production for the Dominion was 1,400,000 tons, which was 107,000 tons more than in February. The imports were, 1,615,000 tons, which was 615,000 tons more than the preceding month. The exports amounted to 174,000 tons.

Output of Coal by Provinces in Short Tons.

	March 1922	Feb. 1922
Alberta	618,000	634,000
Nova Scotia	434,000	344,000
British Columbia	302,000	262,000
Saskatchewan	30,000	35,000
New Brunswick	16,000	18,000
Total for Canada	1,400,000	1,293,000

THE WABANA ORE AGREEMENT

The British Empire Steel Corporation has undertaken to construct a plant capable of producing 100,000 tons of pig iron annually in Newfoundland before 1928. This action is taken following an agreement between the corporation and the Newfoundland Government, the former having arranged to pay a royalty of 25 cents per gross ton for every ton of ore that is mined in the colony. The corporation further undertakes to erect coke ovens and to expend \$3,000,000 in Newfoundland before 1926. It has been arranged that raw materials to be used in the construction of the new plant are to come in free of duty.

Both subsidiaries of the British Empire Steel Corporation—the Dominion Steel Corporation and the Nova Scotia Steel & Coal Co.—are granted rights regarding tax exemption and water power grants. The royalty of 25 cents per gross ton is to continue in force until December, 1940. In the event of either company's failing to carry out the construction program agreed upon, or failing to expend \$3,000,000 in Newfoundland before 1926, an export tax of \$1 per ton will be imposed by the Newfoundland Government upon all ore mined and shipped to anywhere except Nova Scotia.

Who Is Labor's Friend?

By JAMES P. DAY

The following is extracted from a letter written to the New York Times, by Dr. James P. Day, President of Syracuse University, in reply to a criticism of his book, "My Neighbor the workingman."—Ed.

It is a favorite contention with champions of labor unions that all men who oppose the practices of the unions are enemies of laboring men and friends of capitalists.

The union has yielded millions of endowment and established limitless power out of the daily wage of its members. Does any one imagine that but for this enormous revenue their leaders would take such an intense interest in pushing up wages without regard to the economic effect upon the business of the country? The labor union, which might have been of immense service to the country and to the thousands of workingmen who belong to it, has been made a curse to both the land and the workingman. It has denationalized its members and burdened and oppressed the greater numbers who would not join it. Is he an enemy of the workingman who shows these plain facts in an effort to rescue the union from its only real enemy? Warnings are among the most friendly acts among men.

The safety of our country is in the intelligence of its workingmen. We have some very ignorant laborers in the unions and these men are the hope of those who control them. They hold their leadership by them and by them only. But there are increasing numbers of intelligent press-reading and book-reading union men and there are signs that such men do their own thinking and cannot be driven like cattle. The union will be destroyed in its present form or it will be reformed. It will be taken over by loyal, broad, clear thinking workingmen who will be servants of both labor and industrial art, of business economy as well as of day wage. It will be sought by self-respecting men. This will happen or it will perish in the fetid bogs and quagmires of dominating, self-seeking leaders and the ignorance of its members. It can be made as self-contained, self-respecting and self-controlled as the Masonic order, the Odd Fellows, the Citizens Club, or the Chamber of Commerce. No more than do these great organizations does it require loud, open-mouthed champions to bellow riotous threats throughout the land.

I am charged with defending capitalism. I plead guilty. And in doing it I am a friend of the workingman. I do not know how you are going to separate the two. I find capital and labor working together harmoniously when left to their own problems, undisturbed by the demagogues. How is either to get along without the other? They are Siamese Twins in their sympathetic relations, joined by an indissoluble bond. If one were to die the other must die also. What promotes the health of one imparts vigor to the other. The man who would separate them is a murderer, for they cannot be separated without death. No higher compliment could be paid me than the charge that I favor capital. When I do, I favor labor.

In the flush times when thousands of workingmen were so shortsighted that they treated their employers with insolence and left their jobs upon any slight provocation, I said that the great adjuster sure to come was the empty dinner pail. I was sorry that it must come to the women and children of the homes, but it would be wholesome to the men who think only with their stomachs and who feel the force of no other argument. The adjuster has come. He is at the leveling work. Capital is seen to have a place in the poor man's affairs. It is not difficult for an ignorant Italian digging in a ditch to see now the relation of capital and labor. It is plain case that capital will not fill the dinner pail, if capital does not pay the wage, and capital cannot pay the wage if labor will not furnish capital with the hours and the quality of work required in the factories and on the farms. Will the labor philosopher tell us who is to fill the dinner pail? The capitalist has gone as far as he can go in the present plan.

Perhaps the solution is in decreasing the number of laborers by shutting off immigration. That has been a favorite plan of the union, which reduces the number of apprentices and equalizes all kinds of mechanical skill. Capital has had to stand it. But the reaction foreseen as inevitable has come. Shall we charge it to capital? But capital was not the sinner. The union is reaping the fruits of its sins. There is no sinner so hopeless as the sinner who does not and will not know his sins.

I am charged with opposing the strike. In my book I say: "The workingman should abandon the strike, whether the law commands it or not. It is uncivilized and barbarous. It works against higher wages. The menace of it is figured into the cost of every contract. That figures it out of wages."

The cost to business and to the workingman's wages in a single year has been enormous. It is the abandonment of all force of reason by which men should arbitrate their differences and the substitution of physical force, which is always of doubtful expediency because uncertain in its results and of expense which must be paid by the party who can least afford it. It is not the defense of one's property, but the abuse of privileges. There is not a thing about it that is just. No rights inhere in it. The striker does not own anything contested, the property, the business, the time, the wage. The property he did not create. What he worked for he got and took away with him in wage. He did not leave any of it in property which belonged to him. The business was made with other labor which the workingman did not furnish. It was done by an entirely separate class of work and workers. The time he did not bring and could not take from others by any moral right. There is an assumption of a tremendous responsibility when one takes away from another his time by forbidding it or interfering with it. It is so serious that it is guarded by courts of law and protected by guardians of the peace. The State does not refer it to individual contention. It is too dangerous. Every principle of sound community interest denies the right of personal contention. The strike is one of the worst forms of personal violence. There is nothing fair about it. It often is a cowardly advantage.

No one would object it dissatisfied men were to leave a job and go quietly away to another, leaving those satisfied to remain and work, or the employer to hire whom he pleases. That is every man's privilege. It is different from the conspiracy of a strike, which violates every right and privilege and which should be forbidden if any conspiracy is unlawful.

In closing "My Neighbor the Workingman" I argue for higher wage, higher than we are now paying, if the workingman will join the employing man in furnishing the money to pay it. Such a higher wage the employer would be glad to pay and such a wage honestly earned is the only one a laborer has a right to expect.

Our American workingmen, greatest in numbers, found in all callings, dependable in all things, are our greatest citizens. They must never forget that they are citizens.

They must not forget that the capitalists are citizens also, and without them the fires would go out under the boiler and the wheels would not turn an hour. The labor agitator who assails capitalists and makes laborers his enemies is a fool among men and a traitor to the country and to the workingman whom he betrays for demagogic purposes.

True Americans will work together for good citizenship, good business, good wages and good fellowship.

One of the great crimes of this country is to create classes among the quiet working people by setting up conditions each against the other as an arbitrary plan out of which one prospers and the other suffers. Inequality is a law of God and is traceable through the whole universe. Over it the two men born in the first generation quarreled and one killed the other. It has gone on ever since and will continue until men are made of one pattern, and the uniformity then would not last a week. The great law is adaptation; how to get along with what one has in the circumstances in which he is placed is the practical question. We may emulate, but not envy; we may contend, but not be contentious. The field is open. Our progress is not by taking from another what belongs to him, but by adding to all. The high purpose of life is to add to the common good, remembering that we are common people.

How does the workingman feel about capital when he himself becomes a capitalist? Are not the instincts of a laborer to be a capitalist? That is what the savings bank means. He is not a worthy workingman who does not work to the end of making a capital to work for himself, whether hundreds or thousands of dollars. It is pernicious to teach that the only moral virtue is poverty. One can be great and be poor; one can be good and noble and be poor, but one can be neither by being poor. It is how a man handles poverty or riches that makes him what he is.

I cannot look upon the agitator of workingmen as other than the enemy to them and their country. I cannot believe that the apostle was unfriendly to workingmen when he urged them to be content in whatever estate they were. The way out of a less estate in to a better one is by men's own efforts, and their hope is that others are in better estates than they are. The hope of a country is in its workingmen united in a solid compact with its business men—is by the investment of the intelligent laborer's muscle with the capitalist's money. The extreme folly is in setting them apart and in creating an antagonism between them.

Capital is labor's hope. Labor is capital's hope. The two cannot separate; neither one can go alone.

METAL TRADES IN BRITAIN

Iron and Steel.—The continuance of the dispute in the engineering trade is having an increasing effect upon conditions in the iron and steel industries, more particularly as regards the home trade. The demand for material has fallen away considerably owing to the lessened output of engineering products throughout the country and business in iron and steel material for the home trade is consequently of a very limited character. Consumers are, however, keeping in close touch with the market and there are indications that as soon as the labour troubles are settled a good demand will arise.

The improvement in export business reported previously in these pages has been well maintained and has offset, to some extent, the depression in the home market. The pig iron branch of the trade is the one which has benefited most by the increased demand from overseas but even in this branch the aggregate volume of business passing is insufficient to induce makers to increase their output to any appreciable extent, and there is the possibility that the sudden throwing on to the market of a large number of orders held back pending a settlement of the labour disputes may have the effect of forcing up prices. This applies not only to pig iron, but to other classes of iron and steel material, and consumers might do well to pay some attention to this aspect of the situation.

Germany has been one of our best export customers and has bought during the past few weeks about 12,000 tons of pig iron. Other countries which have taken good quantities are Belgium, France, and Italy.

The sharp advances in American prices of iron and steel material, which have occured as the result of the coal strike in that country, are likely to bring an increase of business to the United Kingdom from overseas. Immediately before the strike considerable competition was being experienced from America, especially in the Indian and Far Eastern markets, but the increases in American prices have been followed by an appreciable expansion in the enquiries received from abroad by British firms, and it is anticipated that a fair amount of business will be secured.

The National Federation of Iron and Steel Manufacturers reports that the production of Pig Iron in April amounted to 394,300 tons or 4,500 tons more than in March. This figure compares with an average of 669,500 tons monthly in 1920 and 855,000 tons monthly in 1913.

The production included 152,900 tons of Hematite, 124,700 tons Basic, 80,800 tons Foundry and 16,700 tons Forge Pig Iron.

The furnaces in blast at the end of April numbered 112 compared with 107 at the end of March and an average of 284 in 1920.

The production of Steel Ingots and Castings dropped in April to 404,200 tons from 549,400 tons in March.

The following table shows the average monthly production of Pig Iron and Steel Ingots and Castings in 1912, 1920 and 1921 and in each month since April, 1921.

	Pig Iron. Tons.	Steel Ingots and Castings. Tons.
1913: Average Monthly	855,000	638,000
1920: Average Monthly	669,500	755,600
1921: Average Monthly	217,600	302,200
1921, April	60,300	70,500
May	13,600	5,700
June	800	2,700
July	10,200	117,200
August	94,200	434,100
September	158,300	429,300
October	235,500	405,400
November	271,800	443,800
December	275,000	381,000
1922, January	288,000	327,500
February	300,100	418,800
March	389,800	549,400
April	394,300	404,200

Metal and Thermit Corporation, New York, announces the removal of its Pittsburgh Branch Office from 1427 Western Avenue, to 801-807 Hillsboro St., Corliss Station, Pittsburgh, Pa.

Pure and Applied Science

(Abstract of address delivered by Dr. E. H. Griffiths L.L.D., F.R.S., at a Special General Meeting of the South Wales Institute of Engineers, held at Cardiff, Wales, on March 23, 1922.)

Editor's note:- Dr. Griffiths' address, the full text of which appears in the Proceedings of the South Wales Institute of Engineers, is a strikingly lucid statement of the relationship subsisting between pure and applied science. The whole address, as will be gathered from the extracts and digest presented below, is what our neighbours of the south would call "inspirational." It typifies the mode of thought, the high mental plane of the best British men of science. Scores of men like Dr. Griffiths are doing their utmost to spur the youth of Great Britain on to equip themselves for scientific research. In Canada the awakening is yet to come.

A CLOSER UNION BETWEEN PURE AND APPLIED SCIENCE

Let me call your attention to the conditions prevalent some hundred years ago, after the close of the Napoleonic wars; those conditions in certain respects largely resembled those now existing. The same want of employment prevailed, discontent evidenced by riots was prevalent throughout the country. There was, however, an essential difference. The comparative smallness of our population might have made it possible for us to have become an agricultural community and self-supporting, but no such possibility is open to us to-day. That period, however, was followed by one of unexampled prosperity, and the basis of that advance was found in the application of science to the affairs of mankind...

About 1830 we entered on a period in which the discoveries of science were utilized for the purpose of industry; a period of the replacement of manual by steam power. The discovery that one engine could do the work of a hundred men, and that so far from diminishing it increased employment, altered the whole face of our civilization. If, for example, a few thousand puddlers were thrown out by our employment of the Bessemer and Thomas processes, the increase in the output of steel gave employment to twenty times that number in the engineering trade...Workingmen never make a greater mistake than when they resent the introduction of machinery...

It is but slight exaggeration to say that this country had in the middle of the last century command of the industrial markets of the world. This supremacy, however, steadily diminished during the remaining years of that century, and this was due mainly to two causes:—

(1) Our great industries were controlled by able business men, but men with no scientific knowledge and with but little respect for it, and "rule of thumb" methods were prevalent; research was ignored.

(2) Other nations felt that their existence as industrial communities was threatened, and Germany, more especially, entered into the lists and profited by our mistakes...Her industries were guided by men with both business instincts and real scientific knowledge, a combination rarely found in this country.

It was in the laboratory of an English chemist, Sir William Perkin, that the discovery of aniline dyes was made nearly seventy years ago, yet the manufacture passed into the hands of Germany, which resulted in that multiplication of her chemical resources the effect of which we discovered during the war..... Why was this all-important industry taken from us? I believe the bed-rock causes were the indifference of our business-men to the discoveries of science and the want of co-ordination between the men who apply, that is, the engineers and manufacturing chemists, and the men who work at research in the laboratory, and we have paid dearly for our indifference.

It has been well said that this country has lost its pre-eminence in the dyeing and coal-tar industries because "the English manufacturer considered that a knowledge of the benzol market was of greater importance than a knowledge of the benzol theory."

It would be easy to multiply examples of industries founded on discoveries made by Englishmen and applied by the Germans. Hence to-day our position is, in many respects, more difficult than that of a hundred years ago. For our competitors are beating us at our own game. Is this due to lack of brain power or intelligence on our part? I do not for a moment believe it. The names of men who have made, and are making, the basic discoveries on which industries are or can be founded are in English and French rather than in German lists. Is it that our engineers are incapable of applying the knowledge thus placed at their disopsal? Again, I do not believe it. In the list of the great engineering achievements of the last century, with perhaps the exception of the Suez and Panama Canals, the names of English engineers are pre-eminent. In a popular vote taken by an American publication named *Popular Mechanics* as to the seven most wonderful applications of science for the purpose of mankind, the achievements which obtained the highest number were wireless telegraph, the telephone, the aeroplane, radium, antiseptics, spectro-analysis and X-rays. *Each one of these had its foundation in purely scientific work, and was not the result of deliberate intention to make something of service to humanity...*

During the past hundred years all the conditions of civilization have been transformed, not by legislators, not by soldiers or sailors, but through the agency of men seeking after knowledge for its own sake...

The conversion of a laboratory process into a commercial proposition requires both faith and capital. In the past the British business man has not been prepared to supply the capital until the commercial application has been proved successful. This, however, was impossible unless the necessary capital was provided; and thus we have travelled in a vicious circle... If our technical experts in engineering and chemistry devoted more of their energies to exploring and applying the stores of knowledge freely placed at their disposal by the pioneers of science rather than in the improvements of methods already established, then I believe we could face the future with greatly increased confidence. Unfortunately, as I have already indicated, there has existed in the past, and to some extent exists in the present, a wide gap between the laboratory and the market place...This is especially noticeable in the lapse of time which seems inevitable between the discovery and its application. Let me give you a few examples:—

In 1831 Faraday...established the fact that it was possible to generate electricity by the expenditure of mechanical work, but it was nearly fifty years before the discovery was used with commercial success in the construction of the dynamo.

Aluminium was discovered by Wohler in 1827. This was simply regarded as a scientific curiosity till about 1860. The manufacture of aluminium is now an industry employing millions of capital and thousands of labourers.

Phosphorus was discovered by Brandt in 1669, and exhibited to Charles II as "A wonder of Nature." It was not until 1834 that it was first used in the manufacture of matches...

About 1870 Maxwell established the theory that waves of light were due to an electro-magnetic disturbance in the ether. It was not until 1896 that Marconi applied for a provisional specification of apparatus for signalling by electric waves...

During the past few years the works of Sir Joseph Thompson, Sir Earnest Rutherford, Dr. Ashton and many others have revealed to us the marvellous constitution of the atom, and are leading us to conceptions of the... nature of the chemical elements, and of the relation between what we have hitherto called matter and electricity, which are bound profoundly to influence the whole nature of future investigation...Our attitude of mind should be, not "Is there any possibility of utilizing a discovery?" but rather "In what way can this discovery be utilized?"...

As we look back on the last century we are driven to the conclusion that our prosperity has been chiefly due to our utilization of the energies supplied to us in centuries long past, and now available in the form of coal.

We are thus living on our capital; it is true that we are learning, but slowly, to utilize its latent energy in more economical methods than we have done in the past, but no thinking man can deny that not only is our capital diminishing, but that it is also becoming less available. The sources of energy in the densely populated regions of the globe are diminishing with increasing rapidity.

I believe the attention of our engineers must be directed to the possibility of actually transporting to our doors the energy daily showered in favoured regions of our earth rather than to the destruction of the sources supplied to us in the past.

I ask you to reflect for a moment "on our income of energy"...Observations by Buchanan taken in Egypt with an improved calorimeter led to the conclusion that each square metre of the earth's surface which is exposed perpendicularly to the sun's rays receives radiant energy equivalent to 1 h.p. Now the area of the great circle of the earth is roughly speaking 130 billion square metres, thus the working value of the sun's radiation to us is about 130 billion h.p.; if we deduce from this the h.p. radiation per 1 square foot of the sun's surface we obtain a value very decidedly less than that obtained by Lord Kelvin (7,000 h.p.)...If the radiant solar energy falling on the earth were wholly converted into mechanical energy, each individual's share (including men, women, and children) would enable him to lift a weight of 3,300 pounds through a vertical distance of nearly 20 miles every minute of his life!

It is true that by application of water power the swing of the tides, the growth of plants, the combustion of wood, etc., we do, to some slight extent, utilize our income, but the fraction thus expended is negligible.

I venture to predict that our engineers and chemists will in the future have to rely on *direct* rather than on what I may term the indirect utilization of the energies supplied us by nature...I may doubtless seem guilty of presumption when I suggest to our rising generation of engineers and chemists the advisability of "going back to nature", that is, to a study of natural phenomena. By the combustion of coal at a temperature of thousands of degrees we evaporate water in a boiler, and by means of ponderous and ingenious machinery transfer energy by an electric current to our incandescent lamps. The actual light energy that we thus obtain is but a tiny fraction of the energy expended in the furnace. Consider by way of contrast the glowworm; it is estimated that it utilizes as light some 95 per cent of the energy expended, and that without any appreciable rise in temperature.

Again, consider the astonishing prospects opened out to us by the discovery of the energy within the atom.... If we could but learn the way to persuade the atom to commit suicide, and also discover how to utilize the resulting legacy of free electrons, then we should have no need to consider other sources of energy. The dissolution of radium (and also some other elements) indicates the possibility of such a process, and improbable as may be the realization of such a dream, it is not for this generation to assign limits to the march of discovery...

There is no branch of natural science which the engineer can afford to ignore. His dependence on the physicist, the chemist and the geologist is obvious, but I ask you to remember that the successful construction of the Panama Canal was due to the researches of zoologists, and even the designers of our aeroplanes had to call on the botanists for advice in the selection of their wing materials.... We must remember that all branches of sciences are parts of one organic whole... It appears to me that one of our difficulties is the tendency to over-specialization. The engineer should have easy access to all chambers in the temple of science... I want to induce our young engineers to be both optimistic and imaginative...

Determine that you will become liaison officers between the allied armies of pure and applied science. To the man of science, discoveries are an end in themselves; by the engineer they should be regarded as foundations on which he may surely build for the edification of mankind.

STEEL OF CANADA SALES IMPROVING

"Sales are showing improvement," was the announcement yesterday by Mr. Robert Hobson, president of the Steel Company of Canada, Limited, subsequent to the directors' meeting at which the regular dividends of one and three-quarters per cent. upon both the preferred and common stock of the company were declared for the quarter ending June 30th, payable August 1st to holders of record, July 8th.

The directors met at Toronto and the stock market was not allowed to give any expression to the announcement as the meeting was not concluded until after the exchanges had closed.

The new plant for the concentration and sintering of lean magnetic iron ore at Babbit, Minn., will begin to produce in quantity during May. It is considered now that the problem that remains to be solved is a system of mining that will give a minimum of cost. So far as the mill is concerned, everything that comes up goes through the whole process without any handling,—no selection, no cobbing, just a steady stream of earth's crust pouring in at one end, and coming out at the other in two streams, sintered ore and tailings. It sounds rather like the oft-pictured ideal sausage machine, where the animal walks in at one end, and comes out at the other end in sausage cases—but with the sausage machine there are no tailings!

The Manufacture of Light Steel Castings*

By H. BRADLEY, (Sheffield)

In this Paper, which has reference to the practice of light steel castings, any reference to academic or laboratory practice has been purposely omitted. It is dealt with from the author's practical experience of a general jobbing steel foundry, making all classes of steel castings from a few ounces up to 14 tons in the rough, and with metal of carbon content varying from 0.08 to 1 per cent. and over, and additionally in chrome and manganese steels.

The Plan of the Foundry

To run a foundry successfully, the largest output with the minimum amount of handling must be attained. To carry out this successfully, the shop should be planned for the pattern to enter at one end (where there should be shelves or pockets to receive it) and the core boxes with card attached, with works order number, description, and quantity of. The card is ruled at back, so that each day's cast may be entered thereon. When the pattern and core boxes are given to the moulder the card should have the man's check number marked on, together with the date.

When possible there should be a separate bay for dry sand moulds. The work for dry sand should be commenced at the end of the shop, then carried down to the drying ovens, then to the closing and casting floor, where the moulds should be arranged in straight lines, and all runner bushes should be as near one height as possible, so as to avoid hoisting or lowering the ladle. The steel plant should then be fixed as near as convenient, utilising the floor nearest to it for the green-sand moulds, as these are generally of the lightest section of castings, and, therefore require the steel when in its most fluid state, to avoid short- or faint-run castings.

When the steel is a little on the stiff side it can be used for the thicker section castings. The boxes, after casting, should then pass on a little further to be knocked out and examined, and a note taken of the good and defective castings and recorded on the back of the abovementioned card. When the job is completed the card should then be handed in to the foundry office, the castings going forward to the cleaning or dressing shop, which should be at right angles to the moulding shop, with tram lines running from one to the other.

The fettling or dressing shop should be equipped with shot-blast plant, oxy-acetylene burning plant, and both circular and band saws, according to size and class of work and output. The castings should then go to the machine shop and despatch shed.

The Making of Castings

The first thing to consider is the pattern making, which depends, firstly, on the quantities of castings required from each. A good wood pattern will withstand the making of 500 castings from it, either by hand or machine. If repetition work is carried out, then either brass or white-metal patterns are necessary, which should be on the machine for small castings. The author prefers the hydraulic machine for boxes up to 24 in. round or square, and for deep-lift pattern the roll-over machine. For anything over 24 in. the jarring machine can be used to better advantage.

* A Paper read before the Birmingham Conference of the Institution of British Foundrymen.

The difference in making a pattern for machine moulding and hand moulding is that it is always necessary to fix core-prints to the pattern for the former under any parts that are undercut, as the sand is jarring downwards, therefore, it naturally falls away from the underside of any projecting part.

Tackle.—The boxes should be strong, light, and made of steel. They should all be interchangeable according to the various sizes either for hand or machine. The double lug box is best, giving a truer alignment. The double lug can be either a slot and hole or two holes.

For patterns with small quantities off and intricate joint, a plaster oddside should be made, as they are easy, cheap, and durable.

For large orders or repetition work, machines are a necessity. They do good in two ways, i.e., by reducing costs, and increasing output on the jobs they are working. They also speed the work up generally in the shop. Two boys working a machine with boxes 10 in. by 10 in. by 4½ in. have produced 180 complete moulds in the day with from two to four cores in each. Two youths, 17 to 18 years of age, have produced 62 moulds, 18½ in. by 16 in. by 5 in. deep, painted and blacked. The quantities vary according to size of boxes and design of castings. To get the full advantage from the larger machine it is essential there should be an electric crane specially for its use.

For large quantities of light castings, the Tropenas vessel or electric furnace are to be recommended.

To ensure sound steel castings it is essential to have in the first place a good steel, that is, steel containing the correct composition for the work required, and properly "killed," in order to ensure it lying quietly in the mould. It is also as essential that the sand be suitable; if being used green, it should have just the correct moisture, and just sufficient bond to work it. Sand, in the first place, should always be dried before milling in order to get the required moisture by adding water, and the necessary binding material. The author prefers to use the natural sands whenever possible. The sands generally used in England for steel castings are Belgian loam, used either by itself or with a small amount of silver sand, cornish loam with silver sand, and Yorkshire sand with silver sand. Of the three mentioned, the author prefers Yorkshire, as it is easy to work, is tough, but not too close, gives a good skin on either dry- or green-moulded castings, and does not cake in the mill as much as the first two. For cores, the author's practice is to mix eight parts of silica to one of Yorkshire and up to 4 to 1 for moulds, varying, of course, according to weight and design.

Running and Feeding

Where possible the best system is bottom runners, and in one of the thinner sections of the casting. Careful judgment is required for feeding heads to have the required size and in the right place in order to get a solid casting and avoid wasting steel.

Very soon after casting all runners and feeding heads should be released so as to enable the contraction to take place and avoid having a pull in the casting.

When the pattern is made, it should in the first place be taken into consideration as to whether the casting is to be made green or dry, and the decision generally arrived at is based on how much machining is to be done on the

casting, and whether the difference in the two methods of moulding is worth the risk of making an unsound casting by making it in green sand. A further consideration depends upon design of the casting. In such cases it is essential to make it green to allow for the contraction strains taking place and preventing the casting pulling into pieces. In some cases the weight and design must be taken into consideration in deciding these points. If there is no danger of the casting pulling with a dry-sand mould owing to design, it is always much safer to produce a sound casting from dry-sand work than from green-sand work, owing to the properties of the steel used for casting. Of course, there are many different designs of castings to be contended with, and the greatest trouble given to a steel foundry manager is often caused by the designer not having had any steel foundry practice. To produce good, sound steel castings it should always be the aim to have the thicknesses of the metal as much alike as possible. Wherever thick or bulky pieces of steel are joined together with lighter sections, means have always to be found (if the design cannot be altered) to overcome the difficulties encountered. This can be achieved, either by using chills or causing the thick portion to freeze approximately at the same time as the thinner sections. In some cases, however, a reinforcement is used, but this is not always a wise policy, owing to the possibility of a mishap, after the casting is put to work, disclosing the reinforcement in any fracture. Naturally, the blame would straight-away be put down to this method. This can be further illustrated by a large mill pinion casting of, say, 2 ft. 6 in. tooth face by 3 ft. diameter in the tooth portion, reduced down to, say, 18 in. or so on the neck portion. The best method of producing this class of casting is to have it cored out. At times, however, it is found that engineers object to this method of coring out. They state they must have a solid casting. In order to meet their views, as far as possible (which steel founders, of course, have to do), it is endeavoured to produce a solid casting. This, however, is an impossibility without some method of reinforcement, as it is impossible to feed the body portion of the casting of the dimensions mentioned, through the size of the neck and the wobbler. Therefore, the method of reinforcement has to be used. This is accomplished by putting in what is called locally a "dummy", sufficiently large to prevent the pipe forming through the top neck and wobbler, which would take place unless something of this description was carried out.

Again in the case of hydraulic cylinders, in most steel foundries, there does not seem to be any set way in which to cast them. This is done, either mouth downwards or upwards, but in any case there should be taken into consideration the location of the large bulk of the steel, and the best means of feeding it. As will be realised, it is necessary to feed all steel castings from the head. In iron foundries, a wrought-iron or mild steel feeding rod is used, and small shanks of metal are poured in time after time until it is set. This method cannot be adopted in a steel foundry, as it would pull out the steel instead of causing it to become more solid as in the case of iron castings.

Another useful illustration is that of locomotive castings. The various parts of these are rather troublesome to make, owing to the varying thicknesses of the strengthening brackets, and it is necessary to give much consideration before starting work, otherwise much trouble is certain to result. These castings, are very often made as light as possible, and thick and thin sections are more usually encountered in this class of casting than in most other classes

Core Making

The Core Shop should be self-contained, with special drying ovens, as these play an important part in the making of good castings. The stoves should have facilities for eliminating the moisture as most cores are made either with oil-sands or Bindsandrite, which under the slow baking throws off a lot of steam or moisture. The sand for cores should be very carefully regulated for different classes of work, should be very refractory with just sufficient bond to stand up to the steel, as there are so many castings which if the core does not collapse very quickly would be wasters; especially in manganese castings such as tramway points and crossings, owing to the contraction. A machine for making standard cores is a great help, as ordinary standard round cores can be stocked and kept in dry places. Obviously it produces a better core as wooden boxes get out of shape.

Fettling

Cleaning plays a very important part in the costs, and is always a greater speculation than any other process, owing to so many contributory causes. It may be the sand, or the "compo," but generally, in the author's opinion, it is owing to casting the steel at wrong temperatures. It will be realized that with a ladle of steel, varying from, say, 36 cwt. to 56 cwt., it is almost impossible to have sufficient moulds on the floor at one time to take it at its varying temperatures to suit all castings. But many of the troubles in this department can certainly be overcome with a good shot-blast plant, pneumatic hammers, and swing grinders. There are three methods of removing the feeding heads—burning, sawing, and cutting by the lathe, and obviously the choice will be determined by the design of the casting.

Annealing

It is obvious that the question of annealing depends largely upon the size of the foundry, and output. The best method, in the author's opinion, is the gas-fired stove, but for general jobbing work, where all classes have to be dealt with, the moveable top is as cheap as any for fairly large quantities. For quick and urgent work—say where it is required to cast one day and deliver the next—a small handy furnace of about 8 ft. by 5 ft. with a door at the front of the furnace can be built, and operated with lever and balance weight.

In conclusion, there are many other points appertaining to the manufacture of steel castings, but those enumerated should be sufficient to provoke an interesting and profitable discussion.

The Volta Manufacturing Company, Limited, of Welland, Ontario, Canada, have recently received an order from Renton and Fisher, Limited, of the Hopetown Steel Works, Bathgate, Scotland, for one of their standard 3-ton capacity Electric Steel Furnaces, with transformer and switchboard equipment complete.

The Volta Manufacturing Company, Limited, also build the "Duplex-Voltage" or "Quick-Melting" type of furnace, of an improved design, for melting brass, aluminum etc. Some of their more recent developments include baking ovens, electric soldering iron heaters, electric babbitt heaters, electric water heaters, etc.

Single-Phase Electric Furnace*

By H. P. Abel, A. A. Liardet and W. West

The use of the single-phase electric furnace in the metal industry has not been developed to the extent that its advantages really entitle it. The reason for this lies in the fact that a comparatively heavy single-phase load is not an advantage to a 2, 3 or polyphase generator, this being the type of alternating current which is most generally supplied by large power-stations. Small furnaces, such as are used for melting non-ferrous metals, are made of the single-phase type, and their number is steadily increasing, especially in the United States, where the use of the electric furnace for melting alloys of copper, zinc and tin is much more developed than in this country. There are, however, several large single-phase furnaces in operation in this country and elsewhere, and where these are supplied with power from stations having large generating units very little trouble has been experienced. The out-of- balance effect produced by taking single-phase current from a 3-phase generator can be minimised by installing three furnaces, each supplied by current from a different phase, or by using two furnaces with "Scott" connected transformers, a method of connecting up the transformers to the supply mains, so that power on the high tension side is taken from all three phases, while single-phase current is fed to each furnace.

Rotary machines have been designed and made to take three-phase currents and deliver single-phase. These machines give quite a reasonable efficiency, but they add to the complication of the furnace installation, and therefore are not looked on very favourably. There is no doubt that owing to these difficulties the single-phase furnace, especially for large inputs—300 k.v.a. and upwards—has had to give way to the two- or three-phase furnace. Even in the United States single-phase furnaces are rarely met with, and where they are installed their operation is subjected to stringent restrictions imposed by the power companies. At Buffalo, which is not more than 20 miles from Niagara, with its huge power undertakings, a steel foundry, with three single-phase furnaces, is confined to night working only. This is regrettable, as in a good many ways the single-phase furnace represents many advantages over the other styles.

Details of Furnaces Described

In the foundry with which the authors of the Paper were connected each furnace has a normal capacity of 30 cwts. of molten steel, although as much as 45 cwts. is often obtained at one tap, when the linings have been partly burnt away. Working continuously over a period of 120 hours, about 170 tons of molten steel in the ladle can be obtained, being approximately 10 cwts. per furnace per hour. The charge consists of cold scrap, mostly in the form of mild steel turnings.

Ease of Regulation

From a constructional point of view, a single-phase furnace with only one movable electrode, it is almost unnecessary to emphasise the great simplification of the controlling mechanism from furnaces having two or more electrodes. Not only does the actual raising and lowering mechanism consist of one single pinion and rack, but the complications produced by variations in the resistance of one are reacting on the others, as in the case of furnaces with more than one electrode, is entirely absent. With two- or three-electrode furnaces it is necessary to install an automatic regulating-device to maintain each electrode in such a position as to ensure an approximately even distribution of the current between each of them. With the single-phase furnace no such device is necessary, as the burning away of the electrode has no other effect than increasing the length of the arc, hence reducing the amount of energy in the circuit. This can be detected immediately by looking at the controlling voltmeter and corrected by a slight turn of the handle attached to the electrode raising and lowering device. The single-phase furnace, with its single-electrode, lends itself admirably to the simplest form of construction, a cylindrical shell with central electrode — simple to build and simple to maintain as regards the lining. This cylindrical form offers the least area of external surface for heat loss by radiation. At first sight this cylindrical form might appear to offer disalvantages for the fixing of the doors, spouts, etc. Steel castings can be attached to the shell to produce the necessary flat surface.

Constructional Details

The mechanical details of construction in connection with the water-cooling devices for the electrodes is of the simplest nature in the single-phase furnace. It is usual to use a steel conductor in the base of the furnace, one extremity of which is in contact with the actual metal charged into the furnace, the metal thus forming one pole for the arc, the graphitic electrode above forming the other. This steel contact is water-cooled at its lower end, the water service to it being connected in series with the water service to the electrode holder. A loose cooler is placed on the roof of the furnace and surrounds the electrode, so as to cool it and that part of the roof immediately surrounding it. In the ordinary way the gas pressure inside the furnace causes a constant flame to be projected through the space between the electrode and the roof of bricks. The cooler prevents excessive burning away of the electrode at this point. This trouble has been greatly minimised by forming holes in the roof arranged on a circle at some distance from the electrode, through which the burning gas escapes, thereby eliminating the passage of the flames around the electrode. The furnace is mounted on two rockers which rest on rollers, so that the centre of the furnace, as given by the radius of the rockers, remains stationary when tipping. The furnace is tipped by a crank and connecting rod. The circular roof of a single-phase furnace can be readily re-bricked, as taper bricks readily wedge themselves into a circular ring, whereas with a two- or three-electrode furnace the roof is generally rectangular in shape, to accommodate the electrodes, thus necessitating some form of arch template to ensure the bricks being maintained in position.

A single holder, which is fixed to an arm which moves up and down vertically in a channel iron structure which is hinged to the body of the furnace, allows the electrode when raised just clear of the roof to be swung to one side, so that it and the arm supporting it are quite clear of the roof. This allows the latter to be removed bodily and readily by means of an overhead crane, which is a great advantage.

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* A Paper read before the West Yorkshire Metallurgical Society. From "Foundry Trade Journal."

Oyster Roofs

Some of these same type of furnaces are made with a hinged roof, which can be opened like the shell of an oyster, thereby facilitating charging. In this case the electrode holder is hinged in the same plane, so that the electrode swings back with the roof.

Difficulty had been experienced with this type of furnace in maintaining contact between the bottom of the steel electrode and the metal in the furnace after recharging. This was due to the fact that slag was left in the bottom of the furnace, which formed an insulating layer between the metal electrode and the new material which was charged in. This difficulty was surmounted by making use of a small dummy steel electrode, which is placed in the bottom of the furnace immediately after the charge has been teemed, and which is held in an upright position in contact with the bottom electrode whilst the new material is thrown into the furnace. This gives a satisfactory contact between the bottom steel electrode and the metal in the charge.

If the furnace is to be designed for any given power input it is immaterial, electrically speaking, whether this power takes the form of a relatively heavy current at comparatively low arc voltage or *vice versâ.* High voltage gives a long arc and low voltage a short arc.

Electrical Efficiency

In the case of multi-electrode furnaces the electrode pressure is, however, limited by the leakage which tends to occur through the refractory roof between electrodes and also by the fact that in furnaces of other than cylindrical design certain portions of the lining which are situated nearest the arcs tend to become over-heated by direct radiation from the arc unless shielded by the electrode itself. Such shielding action only occurs if the arc is so short as to bring the electrode close to the surface of the bath.

The short arc of a low-voltage furnace requires a comparatively heavy current. This means that electrodes of large cross section must be used with relatively heavy usage and expense.

Electrode Consumption

In single-electrode furnaces where the arc is practically equidistant from all parts of the lining and the possibility of roof leakage is entirely eliminated, a considerably higher arc voltage may be employed, affording the following advantages: (1) Small diameter electrodes, with consequent low electrode consumption; in the installation with which the authors of this Paper are chiefly experienced, 4-in. electrodes are used in furnaces having a normal input of 400 kw. (600 k.v.a.), and the total consumption of electrodes is no more than 8 lbs. per ton of steel melted; (2) comparatively small cross section of copper in electrical connections, with consequent saving in installation expenses; (3) the possibility of employing reactance control of furnace input.

The last point constitutes perhaps the chief electrical difference between the single-electrode and the multi-electrode furnace, and deserves rather detailed attention.

In the case of any electric furnace of considerable size a certain amount of reactance must be included in the electrical circuit with a view to limiting the extent of the current fluctuations which occur when the arc is unduly shortened, or when, during the melting of cold scrap, the charge collapses and falls against an electrode.

Such reactance is, however, generally kept as low as expedient in order to maintain a relatively high power-factor, with the consequence that considerable current and power fluctuations do occur, and the load-factor over any period of time is therefore poor.

Power Factor Sacrificed or Control

In the single-phase single electrode furnace the disadvantage of a low power-factor is deliberately incurred, for the sake of the delicate control, and a high working-load factor which the use of large reactance, in conjunction with high arc pressure, allows.

Transformer Details

The transformers, by means of which the high tension supply is stepped down to furnace pressure, are themselves designed with considerable inherent reactance, and, in addition, a large independent reactance can be cut in or out of circuit by means of suitable switch gear. The effect of such reactance is to cause the furnace voltage to reduce rapidly as the furnace current rises, and at the same time to reduce the power factor with increasing current.

Electrical Characteristics

If the total reactance in circuit is such as to entail at normal load a power factor of 0.7 or less, the effect is to impose an absolute limit to the power or kilowatt-input, so that if the furnace current exceeds the normal the power input will actually decrease.

A diagram giving the result of a series of readings taken under actual working conditions on a furnace of this type, having a normal full load current of 2,750 amps., showed that the open-circuit pressure of 200 volts reduces to about 140 volts at full low current, while the kw. input, rises to 400. If the current is allowed to increase beyond 3,500 amperes the kw. input, having risen to 420, commences to decrease. The fall of kw. input becomes more rapid with further increase of the current, and it is actually possible to short-circuit the arc by feeding the electrode down until it touches the bath, and under these short-circuit conditions the power-input will be something under 150 kw. Current overload equals 50 per cent. amp.

Over the working range of current variation the kw. input remains practically constant at about 400 kw.; in other words, the working range is around the peak and on the falling side of the kw.-input curve.

A series of similar curves illustrate the effect of switching additional increments of reactance into circuit. The three positions of the reactance switch giving maximum power inputs of 420,360 and 325 kw. respectively.

The great disadvantage inseparable from the above form of control is the very poor electrical power-factor, which approximates to 0.6 at normal load. This not only increases the cost of electric supply taken on maximum demand tariff, but renders the load undesirable to an electric supply company, in spite of its high load-factor.

A diagram taken from a recording wattmeter taken during the operation of a heat illustrates strikingly how slight are the power fluctuations. From this it follows that a very high load factor can be maintained. That is to say, the average power-input is a high percentage of the maximum power demanded, a figure of 70 per cent. being obtainable in practice over the working period, inclusive of charging times.

A method of improving the low power-factor which has been referred to is to install in the same power mains as those feeding the furnace transformers either a static phase-advancing plant in the form of a bank of large capacity condensers or a rotary over-excited synchronous motor which will give a leading power-factor, thus tending to neutralise the lagging power-factor created by the furnace and its reactance load.

In the case of the installation with which the authors are connected the demand for direct-current happens to

exceed the available public supply, which necessitates the conversion of alternating supply to direct currents by means of a motor generator, the motor of this set consisting of a specially designed synchronous machine of approximately 1,260 k.v.a. nominal capacity over-excited to take a current of 110 amps. per phase at a leading power-factor of about 0.3. This serves to correct the power-factor of the plant, comprising three such furnaces, to approximately 0.8.

Power Consumption

Furnaces of this type are distinctly economical in power. The figure of 700 units per ton of steel melted from cold scrap is attained, and frequently improved on under conditions of continuous operation, a safe average figure being 750.

Such furnaces can be used with either an acid or a basic lining, but in the case of the latter a lower arc-voltage must be used.

Basic linings tend to suffer from the radiations from a long arc, which the higher conductivity of basic slag and of the atmosphere above it produces with the employment of a high arc-voltage. As an instance of this, the arc can actually be drawn out to a length of 2 ft. over a basic slag before it breaks, the maximum arc pressure at breaking being 200 volts.

Furnace Control

The control of the furnaces is extremely simple. Owing to the long arc constant manipulation of the electrode feeding-gear is quite unnecessary, even during the melting down of cold scrap. In the case of short-arc furnaces the attendant has to regulate the arc length continuously, if not accomplished automatically.

With a single-phase long-arc furnace, on the other hand, the attendant having struck the arc, adjusts its length till the control voltmeter indicates the prescribed working pressure, and then leaves the furnace until the voltmeter, the reading of which slowly increases as the charge melts down, indicates the correction should be made. This correction is effected by a turn of the electrode feeding hand-wheel bringing the voltmeter back to normal reading. When it is desired to reduce the power-input the circuit is broken by raising the electrode. Additional reactance is then switched in, and when the arc is struck again the voltage is adjusted as before, when the ammeter and wattmeter will indicate reduced power- and current-inputs.

Speed of Working

Melting takes place with rapidity. A 400-kw. furnace will melt and finish a 2-ton charge of cold scrap in about 4 hours or under, and is capable of a steady production of upwards of 50 to 55 tons in a working week of five days.

Acid or Basic Hearths

One of the primary questions which confronts the user of electric furnaces for the production of steel is whether to operate on an acid or basic lining.

This question is invariably decided by a consideration of the product to be produced and the nature of the available scrap supply. The acid process is simple to manipulate, requires less technical supervision, and consumes less electricity than the basic, where more prolonged heating is required to complete the refining operation. On the other hand, with the acid process greater care must be exercised in the selection of raw material, as the ability of reducing the percentage of certain elements in the molten metal is absent.

General foundry practice is distinctly in favour of basic working in the majority of electric furnaces, irrespective of the high cost of basic refractories. This is based on the fact that there is a wide margin of difference between the price of high-grade scrap, which must be used with an acid lining, and the lower grades, which can be satisfactorily refined to produce finished steel to almost any analysis on a basic bottom.

With the high voltage single phase single-electrode furnace, which is the subject of this Paper, acid lining only has been found to be satisfactory as a refractory material to withstand the severe heat radiation from the high voltage arc.

The single-phase single-electrode furnace works quite satisfactorily on a basic lining, if worked at a lower voltage during refining, say not exceeding 100 initial volts. This would necessitate a higher amperage, with larger diameter electrodes for the same kw. input. On the high-voltage furnace many experiments have been tried with various basic mixtures, such as magnesite bricks, dolomite with 5 per cent. addition of fire clay, dolomite mixed with hot tar, and rammed into position around a wooden template — but none of these linings proved commercially successful.

The best combination which was used consisted of dolomite and pitch reinforced with iron rods at the most vulnerable points of the lining, such as over the doorways and at the nose of the vessel. This lining only gave an output of 32½ tons of steel, after which the furnace had to be completely relined.

The Lining of Single-Phase Furnaces

Silica bricks of the best quality are used, well kilned to eliminate expansion, and steeped in boiling tar until sufficiently saturated, and then withdrawn to dry. This eliminates all moisture from the pores of the bricks and substitutes carbon, thereby rendering their structure more refractory. Experience has shown that a lining made with bricks treated in this manner has 50 per cent. longer life than one built up of ordinary "white" silica bricks, the life being measured on the actual tonnage of steel.

Around the conical base of the furnace common fire-bricks are stepped and grouted well together to provide a substantial base for building the working bottom and the lining. Keiselguhr was originally used as a heat insulator to minimise radiation, but was discarded several years ago, being looked upon in the nature of an unnecessary refinement. The furnace bottom consisted of a coarse mixture of half-and-half prepared ganister and calcined ganister rock well mixed with hot tar. This is hand-rammed layer by layer until within a few inches from the top of the steel electrode. On this solid foundation a melting area is built up to any desired size within the limits of the diameter of the shell. The lining above the foundation is built up in such a way as to form an inside veneer of bricks, which can be replaced, after a certain number of heats, without having to disturb the outer and greater portion of the lining. The outer ring consists of standard 2½-in. bricks, tapering to 2 in., so arranged that each wedges itself between the two immediately next. This forms an annular wall 9 in. wide, and is the outer lining which is not touched when the process of veneering is carried out. For the inside or veneering specially shaped bricks are used, 4½ in. wide by 4½ in. deep, curved to the radius of the furnace. In this way the lining is built up layer by layer, grouted well together with ground silica brick and fireclay mixed with tar. Large wedge-shaped bricks, called "jambs," are fitted together and inserted to form the charging doors on either side of the furnace, into which the taper plug bricks on the doors closely fit when these latter are closed. This method of

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forming an inner lining or veneer has proved very successful. After one week's output of approximately 30 heats, this inner lining is just about fused away, and it can be replaced very readily during the week-end.

For the roof taper-blocks are used, which are wedged into the roof frame, which is placed on a wooden template to approximate the shape of the internal spherical arching. This arrangement is commended on account of the simplicity of setting these bricks, which allows of a permanence of structure able to withstand the effects of expansion and contraction following changes in temperature.

Raw Material Used

After drying a newly-made lining with a coke fire, a charge consisting of metal scrap in the form of clean steel turnings, crushed in a heavy pug mill, is put into the furnace together with 30 to 40 lbs. of ground-up electrode carbon. A representative analysis of such a charge is: C, 0.3; Si, 0.2; S, 0.05; and P, 0.06 per cent. The melted bath will show a carbon content of about 0.4 per cent.

Advantages of Single-Phase Furnaces

There are two outstanding advantages with the single phase single-electrode furnace not possessed by multi electrode furnaces. Firstly, the whole charge, as described above, can be put into the furnace, the plug doors are closed and permanently luted up, avoiding loss by heat radiation, and the finished metal can be teemed into the ladle without any necessity to reopen the furnace. Secondly, during the first hour, what is termed the cutting down period, the electrode is gradually worked down through the charge to form the initial pool of metal, the surrounding partially fused turnings themselves acting as a shield to the refractory material.

Details of Working a Charge

When this pool of metal is formed the current is cut off from the furnace, and the furnaceman — by means of a long iron hook through the pouring spout — brings the remainder of the charge towards the centre. During the whole process of melting this is the only occasion on which the current need be cut off. The chemical changes which take place in the process of steelmaking and refining in this furnace are entirely similar to those in kindred types working on acid or basic linings as the case may be. When the whole charge is melted the current input is reduced by the insertion of reactance in the circuit — as previously described — and the molten bath is caused gently to boil by means of iron ore additions, which act through the medium of the slag to eliminate the carbon, silicon and manganese. With the acid lining there is naturally no reduction of the sulphur and phosphorus during any part of the working, hence a very rigid observation and control have to be exercised over the quality of the raw material purchased. During the boiling process samples are taken from the bath and subjected to the Eggertz rapid colour test for determining the carbon. Great care is taken to rid the acid slag of all active oxides, to ensure a perfectly reduced condition when the metal bath has arrived at the desired composition. Half the slag is run off from the furnace, and approximately 56 lbs. of limestone is added. This method of introducing a basic material to an acid-lined furnace is contrary to the accepted practice, but has proved very beneficial and satisfactory, neutralising as it does the increased acid nature of the slag derived from the solution of silica which it contains at the high temperatures attained in this furnace. The process of deoxidisation takes place over a period of 20 to 30 minutes. The usual additions of silico spiegel are made, followed by the correct additions of 80 per cent. ferro-manganese and 50 per cent. ferro-silicon.

The whole process of melting and refining is under perfect control in the single-phase furnace, both as regards the final temperature of the bath and the rate at which the charge is melted. In charging it is advisable to pile pieces of loose scrap in the centre of the charge, to prevent what is locally termed a "top-melt." If the charge is all turnings, there is a danger of a solid fused mass forming below the first pool of metal melted, which causes the heat from the electrode to be radiated up to the roof, fusing the bricks, which run down into the metal, further increasing the difficulty of melting. The average time from charging cold scrap to tapping 2 tons of finished steel is four hours.

In conclusion, the authors have not the slightest hesitation in saying that where the difficulties of obtaining relatively large quantities of single-phase alternating or unbalanced three-phase current are non-existent, there is no type of electric furnace which is simpler to handle, cheaper to maintain and operate, and more adaptable for general steel electrode furnace.

B. E. STEEL ACTIVITY

The billet and blooming mills at the Sydney steel plant have gone on double shift lately, according to a statement given out at British Empire Steel headquarters. This new activity will increase the force to over 2,300 men. The mills will roll billets from cold ingots to furnish material for the rod and billet trade.

For the first time in the twenty-two years of its history, the plant has successfully entered the foreign market for finished steel products. Orders are on hand for nails, barbed wire and galvanized wire for Buenos Aires, South Africa, New Zealand, Costa Rica, Colombia, India and British West Indies, it was announced. The largest order is 700 tons for Australia, and the smallest 100 tons each for South America and India.

BRITISH GAINS IN TIN PLATE EXPORTS

Welsh tin plate producers are rapidly recapturing the Canadian Pacific Coast market from American makers. In the first four months of this year shipments of American tin plate to Canada averaged less than 2000 tons per month; in 1913 they were over 4000 tons per month. In contrast, British shipments to Canada to May 1, this year, have been over 5000 tons per month; in 1913 they were only a little over 800 tons per month.

Aprominent Welsh tin plate producer is quoted as saying that "British manufacturers have lowered costs in all directions to a strongly competitive basis. With some exceptions the Welsh tin plate industry has been able to retain most of its old customers and to recover the Canadian market which we lost to the Americans previous to the war."

While it is true that British tin plate exporters have made greater percentage gains this year han their American competitors, they have not yet equalled their pre-war rate. For the four months ending with April, British tin plate exports totaled 143,979 gross tons, against 163,095 tons for the corresponding four months in 1913. American exports to May 1, this year, have been 30,741 tons. They were 25,744 tons for the same four months in 1913, so that the increase has been about 20 per cent.—The Iron Age.

EDITORIAL

THE NEED FOR SPECIALISTS IN IRON ORE

The iron-ore problem is ever with us, and at no time is its solution more pressing than now, when we can ill afford to pay out the huge sum required annually to provide ourselves with this necessity from beyond our borders. Thus every scrap of information that may help us, or any idea that may possibly point the way to a solution, is worthy of close attention.

We print to-day Mr. G. C. MacKenzie's address to the conference on iron ore, held under the auspices of the Minister of Mines in Toronto on July 5th. This is an impartial summary of the present situation, based on the outstanding facts. In common with the majority of those who have studied the question, Mr. MacKenzie finds no immediate solution in sight. However, the solution of a problem such as this is never accomplished until some one provides new information, or demonstrates the commercial feasibility of one or other of the many experimental processes; so that a successful issue rests now, as heretofore, with the experimenter, or researcher, or prospector, who is ready to risk time, labour and money by launching out into the unknown.

Meantime Mr. MacKenzie has a practical suggestion to offer, — a suggestion that is unusually opportune just at present. He points out that we have at present in Canada no geologist who has specialized in iron ore to the extent of making himself completely conversant with our resources of this prosaic but all-important mineral. The geologists in the public service have been shifted from one problem to another, periodically if not annually. If one or more of these geologists were left for a number of years to study iron ore, as has been done with such marked success in the United States, our problem might, by this means, be no problem within a short term of years. We have, up to the present, been merely dabbling in the geology of our iron ranges.

This suggestion is completely in accord with the present policy of the Dominion Geological Survey. As rapidly as it can be practically effected, Dr. Collins is allotting special fields of endeavour to his staff, which they will follow year after year, irrespective of geographic location. The present specialist on iron ore is Dr. G. A. Young, now engaged in examining the deposits of British Columbia. As iron ore is in general the most important of minerals next to coal, and as in Canada it presents by far our most important problem in the mineral industry, there will probably be scope for a number of such specialists during the next quarter-century, both in the public service and in private practice.

A NATIONAL IRON AND STEEL INDUSTRY FOR SOUTH AFRICA

South Africa has decided, through her elected representatives, that she must have the iron and steel industry upon which the industrial system of any modern nation is mainly built. A cabled despatch announces that a bounty on pig-iron and a further bounty on steel has been proposed by the Government. It is asserted that what is at present lacking for the building up of a well-founded steel industry is capital alone, and it is calculated that the bounty, unusually substantial at first, and diminishing to zero at the end of eight years, will be sufficient inducement for large capital expenditure. Coal, iron ore, and fluxes are available in abundance, and railway facilities are, in the main, already provided.

On another page, we review the report on South Africa's iron ore resources recently published by the Imperial Mineral Resources Bureau. This is one of a series of volumes that will describe, in a comprehensive way, the iron ore resources of the Empire and of the world. That these volumes will contain the best information obtainable, and will supersede the compendious volume on iron ore compiled in 1910 by the International Geological Congress, is evidenced by the fact that the Imperial Mineral Resources Bureau is composed of a representative gathering of the Empire's leading mineral technologists, among them our own Dr. W. G. Miller.

The domestic requirement of iron and steel products in South Africa is comparatively small. There is no doubt that the production of these materials in the interior of the African continent will expedite its development quite materially and so will help to expand the home market. But it is upon an export market that South Africa's immediate hope for an iron and steel industry commensurate with her extraordinarily favourable conjunction of resources in iron ore and coal, must depend. As the future centre of steel production is some hundreds of miles inland, it is considered that only the more valuable finished or semi-finished steel and iron products will find ready sale in the world's markets.

It is not impossible that there will be, in the future, a repetition in South Africa of the condition that has made the iron ore industry of the Lake Superior region of the United States unique. The Lake Superior ores have an exclusive market throughout the interior of the North American continent, at present based not so much upon any superior quality as upon the natural barriers that exclude competitors. Coal of the right quality and in sufficient quantity is available south of the Lakes, and as a result

of the settlement of the continent and the liberal use of iron and steel products by its inhabitants, the iron and steel industry of the Great Lakes region has become the largest in the world. Little of its product reaches the Atlantic or Pacific markets, but it supplies the requirements of the larger part of the continent's hundred odd million inhabitants.

South Africa's may be a similar case, and may in time not only provide the iron and steel used in a large part of the continent, but may constitute the centre of industrial activity, which will in turn provide a ready market for agricultural products, and so stimulate a settlement of the vast vacant spaces of the southern part of that continent that now invite the white man's attention.

South Africa's present case is analogous to that in which Canada found herself twenty years ago—but quite different from Canada's case today. At the opening of the century, it seemed certain that the bonus provided for the production of iron and steel in Canada would result in what the South Africans hope for today through the same means. But the two cases differ in the fact that, whereas Canadian calculations were based upon the hope of discovering adequate deposits of iron ore, the South African ore for the purpose is already in sight, in addition to adequate coal reserves.

In this connection it is interesting to note that the Hon. F. S. Malan is South Africa's Minister of *Mines and Industries* — a conjunction of duties that is obviously appropriate, though our Canadian legislators are quite oblivious to its significance. The creattion of this combined ministry and the hearty support accorded the Iron and Steel Industry Encouragement Bill by General Smuts are well worthy of that truly great leader and Imperialist.

THE FUTURE OF IRON ORE SMELTING

The history of iron ore smelting is a very interesting one, taking us back to the Catalan forge of the early centuries or even to a more primitive contrivance still in use among some of the hill tribes of India and in parts of Africa. The iron artificer in need of a fresh supply of the metal goes to where the ore is found, builds a small furnace of clay, makes his charcoal on the spot, and works the blast by leg power using his bare heels as valves. The Chinese still use a simple furnace without blast. It is a long call from that to the modern blast furnace, which after centuries of experience, and of late aided by all the resources of science, has been brought to a fine perfection, —one almost wrote, a *ripe* perfection, but that might suggest the falling of the fruit.

The strong position of the blast furnace depends on its perfect control, physical and chemical, its large output, the production of an impure metal that melts at a comparatively low temperature (1000 deg. to 1300 deg. C.), the easy production of slags melting at slightly above these temperatures, a controlled variation in composition of the slag so as to produce a pig-iron of the desired composition, a low working temperature tending to a long life for the lining, and a minimum loss of iron in the slag. If we add to this the economy in fuel consumption, worked out to a finish by the utilization of the furnace gases for heating the blast and for generating power, the strong position of the blast furnace is evident, and it is not surprising that iron and steel men are very sceptical about any scheme for replacing it. They point out the high temperatures required in all the proposed methods for making steel directly from ore, and the consequent necessity for refractories which will stand up against such conditions. The excessive loss of iron in the slag when working at high temperatures is another disadvantage of all such processes. As to the use of electrical furnaces for smelting iron ore, at present the conditions must be very special, such as cheap electrical power and comparatively cheap charcoal, to allow the profitable manufacture of pig iron in this way. There is more hope perhaps in another direction, the electrolytic, in which the use of the electrical current is particularly efficient. The proposal to reduce to sponge iron by means of producer or other gas, and finish by electrical melting is dismissed as depending on reactions that are too slow to be feasible, but possibly the blast furnace men have not given weight to a consideration which might be over looked by those accustomed to the rapid passage of the furnace gases through the ore in a blast furnace. The flow of reducing gases through a sponge-iron furnace could be regulated so as to allow time for complete reaction, while in the blast furnace the carbon monoxide must do what it can on the way up.

But while the blast furnace is in an assured position, it may be interesting to make a comparison with another old metallurgical appliance, which began its history many centuries ago, and which has been perfected in late years by the use of the best mechanical engineering skill combined with all the resources of the alloy steel manufacturer. The stamp mill has kept its place in the gold fields of the world as a most perfect device for the crushing of gold ore. The weight of the stamp has been gradually increased, from the hand mills of the early ages to stamps of a ton each. But the stamp mill is being replaced, and the reasons for this are interesting. It is a machine for pulverising the gold ore and bringing it into contact with mercury so as to catch the gold as amalgam. But more or less of the gold is refractory, refusing to amalgamate, and in some cases a large fraction of the gold is in this condition. This has led to various methods of treating the refractory concentrate which was obtained from the stream of crushed ore after passing the amalgamating apparatus. The winner among these processes is cyaniding, depending upon the use of a substance, potassium cyanide, formerly very expensive. The large and growing demand for it led to improved processes of manufacture of sodium cyanide, which works just as well. The improvements in cyaniding have made it profitable to use

this method for extracting all the gold, and now it has come to a contest between the stamp mill and other pulverisers, simply as pulverisers, to prepare the ore for cyaniding. In the meantime, the ball-mill and the tube mill have been perfected, and the thunderous roar of the stamps is no longer heard in some of our largest gold mills, the Dome Mines for example. Stamp mills in some cases have been discarded, to give place to these newer crushers, and we hear that one of the largest South African gold mines has decided to instal ball and tube mills. Doubtless the stamp mill will hold its own under some conditions, but what we wish to emphasise is that this well tried old device, the position of which was held to be impregnable not many years ago, must now without any doubt meet formidable competition.

If some one can show us how to make pure steel and pure iron economically without passing through the pig-iron stage, the blast furnace will have to look to its laurels.

THE NEW STUDY OF COAL

Modern methods in the study of chemistry and paleobotany of coal are so radically changed from the methods established by custom and convention that they constitute a practically new branch of science.

With the aid of the microscope and Canada balsam, the four prime constitutents of coal have been isolated, differentiated, and identified. They have also been named. It is a good sign of the spirit of the times that their names "fusian," "durain," "clarain," and "vitrain," are si sort, significant, and mnemonic.

A brilliant exponent of the new study of coal is an Englishwoman, Dr. Marie Carmichael Stopes. In this issue of *Iron and Steel of Canada* we publish an abstract of a lecture delivered by Dr. Stopes at Sheffield University, England. It will be noticed that Dr. Stopes' utterances are not lacking in positiveness. Here is no shrinking violet, no meek disciple, but a challenging personality. Dr. Stopes believes that "the chemist's knowledge of coal at the present moment is that of the Dark Ages, as mediaeval in its crudity and misleading in its apparent exactitude of percentage as was pre-atomic inorganic chemistry." She maintains that knowledge of the microscopic structure and chemical properties of the newly-identified substances that together constitute coal will soon be recognized as equal in importance to a knowledge of petrography and of Metallography in the allied sciences of geology and metallurgy.

Dr. Stopes' definition of coal as "a compact, stratified mass of dismembered 'mummified' plants" is neither elegant nor final; but it is a step in the right direction. Her flouting of the current idea that a special form of flora in the "Coal Measure epochs" was necessary to the formation of coal, is convincing. Three of the names of the integrals of coal were coined by Dr. Stopes, who has made herself not only an acknowledged authority on this phase of paleobotany, but is in demand as a forceful and remarkably lucid lecturer.

What St. Paul would feel or say were he to visit this vale of tears and see women achieving leadership, would probably not be in keeping with apostolic tradition..

For ourselves we welcome the opportunity of paying our respects to a woman scientist whose temerity is exceeded only by her positive accomplishments.

In this issue of *Iron and Steel of Canada* we deal at some length with the question of iron ore. For this we need make no apology, as the problem of iron ore supply in Canada is, or should be, a burning question, and will remain so until it is satisfactorily solved.

TOOL FOR GRIPPING SHEET METAL

Wherever sheet metal is used in a continuous manner some protection is usually provided to prevent the metal from cutting the operator's hands; but where this material is only handled occasionally, as, for instance, in a storeroom, no protective device is deemed worth the trouble and cost. Consequently, many badly cut hands often result. Illustrated in the accompanying photograph is a tool which has been used effectively for the purpose of handling sheet metal in a storeroom. With this device one man can pull out a sheet from a number of others and transport it with ease and safety. For wide sheets, two of these tools are used, one in either hand.

Materials for the tool are inexpensive and there is nothing complicated in the construction of it, the main part consisting of a short length of 2 in. by 1/4 in. strap iron. This has a slot 1/4 in. wide sawed out at right angles to the length, near the end, and near the other end a hole is drilled to clear a stud which is threaded tightly into a file handle, the whole being held together by a nut on the under side of the iron. A glance at the photo will explain to the reader how the construction of the tool permits it to grip the metal as soon as the handle is pulled and why the tightness of the grip increases in proportion to the pull. It will be as well to add that no attempt should be made to smooth the edges of the slot; the rougher these are left the quicker the tool will grip. The device can, of course, be used in an opposite direction to that shown, i.e. upside down, and this position is preferable where the stock is some distance from the floor.

Harry Moore, Montreal.

Canada's Iron Ore Problem

Beneficiation of Ontario Iron Ores*

by G. C. MacKENZIE

MAGNETITE

As a general statement it may be said that the known deposits of Ontario magnetites are unfit for blast furnace use in their natural condition. There are, it is true, a few isolated and small deposits of high-grade ore, but these do not affect the main result nor are they of much importance because of the very limited available tonnage.

We have, however, a number of iron ranges containing large amounts of siliceous or sulphurous ore, such as Moose Mountain, Tomagami, Atikokan, Goulais River, Mattawin, etc., in Northern Ontario, and several smaller and relatively less objectionable deposits in Eastern Ontario, such as at Bessemer, Blairmore, Belmont, Coe Hill, Glendower, Robertsville, Calabogie, etc.

Comparing the ores of Eastern Ontario with those of the Northern portions of the Province, it may be said that the former have been found to be more readily amenable to beneficiation, while the latter are more easily mined. This is because the eastern ores are of a more coarsely crystalline type requiring less preparatory grinding, while the cost of mining has been relatively high because the deposits are not large. The Northern ores of finer crystallization require more preparatory grinding, but they have been mined more cheaply because the deposits are of considerable size.

The beneficiation of a magnetic ore is, from an engineering standpoint, a comparatively simple operation. The ore is first crushed to a size at which the objectionable gangue is freed from the particles of magnetite, and is then passed through magnetic separators which select the magnetite, allowing the gangue to pass off as waste. The concentrated magnetite is then agglomerated by means of heat to make it suitable for blast-furnace use.

If the original ore requires grinding to say 1/8 inch or finer, it will be necessary to submit the crushed ore to wet magnetic concentration; but if the ore can be freed from its gangue at say 1/4 inch or larger size, dry magnetic concentration may be employed. Practically 90 per cent. of Ontario iron ores both east and north require grinding to at least 1/16 of an inch, many much finer with subsequent wet concentration.

The agglomeration of the concentrated magnetite is not as simple an operation as its concentration. The agglomerated product must be strong, porous, and not subject to weathering effects. If properly made, this artificial iron ore is an ideal raw material for the blast furnace, but if improperly made it gives rise to various kinds of furnace trouble.

The purpose of beneficiating any given ore is to make it suitable for blast furnace use, and unless the beneficiated ore can compete with natural ores in quality and price, the venture must prove unprofitable.

Operating Plants in United States

It has been proved in actual practice over a long period of years that under certain favourable conditions a lean iron ore may be mined, concentrated and agglomerated, yielding a desirable product for the blast furnace, and at a cost which enables it to compete with natural ores. The work of the Pennsylvania Steel Company, of Lebanon, Pa., and of Witherbee, Sherman & Company, Mineville, N. Y., are instances of successful operations during many years. At Babbitt, Minn., the Mesabi Iron Company are nearing the completion of a very large plant for the concentration of magnetic ores containing between 20 and 30 per cent. iron.

The favourable conditions under which the Lebanon and Mineville plants have been successfully operated are, large deposits or crude ore which admit of cheap mining, the adoption of most suitable methods of concentration, and a product which finds a steady market because of its desirability. The Mineville plants produce a coarse, crystalline product by dry magnetic cobbing, which does not require agglomeration. The Lebanon plant produces a finely divided concentrate, which is subsequently nodulized. Both the Mineville and Lebanon plants produce a concentrate containing over 60 per cent. in iron and low silica, sulphur and phosphorus.

The Blast Furnace Problem

Some few years ago blast furnace operators in Canada and the United States had no difficulty in obtaining supplies of natural hematite ores from the Lake Superior ranges, which averaged well over 60 per cent. in iron and were relatively low in slag forming elements. Many of these high grade deposits are now exhausted and while for a few years the average ore shipped from the Lake districts averaged 55 per cent. in iron, one is safe in stating that shipments of natural ore in the future will average well below 55 per cent. iron. With the decrease in the iron content there has been a corresponding increase in silica and sometimes sulphur and phosphorus, so that the furnace operator to-day has, on the average, a poorer raw material for his furnace than he had ten years ago, and much poorer than he had twenty years ago.

The decrease in average iron content and increase in average silica content has resulted in more expensive furnace operation, because the furnace-man has to contend with more slag-forming materials, and these in turn require a larger proportion of fuel per ton of ore smelted. Both charcoal and coke have greatly increased in price during the past 20 years, so that the furnace operator to-day has not only a leaner ore, yielding less pig per ton, but more slag to melt which requires a larger proportion of more costly fuel.

If the furnace operator can be supplied with an adequate quantity of beneficiated ore containing over 60 per cent. iron and low in slag-forming elements, he would be able to reduce his fuel bill, and if the beneficiated ore contained very small amounts of both sulphur and phosphorus, he could make a pig iron comparatively free from these elements and correspondingly more valuable. This principle is well recognized in the marketing of natural iron ores and a premium is always demanded and paid for those ores which are exceptionally free from silica, phosphorus and sulphur.

It would appear that all that is necessary is to produce a beneficiated ore better in all respects than the average natural ore in order to secure the highest market price for the beneficiated product. Unfortunately this accomplishment is not easy from a commercial standpoint, and the various attempts made in Canada to produce beneficiated ores have been more or less unsuccessful for many and varied reasons which need not be entered upon here.

* Part of a statement prepared for the conference on Iron Ore in Toronto on July 5th.

Conditions for Commercial Success

It is very easy to adopt a critical attitude over the unsuccessful attempts at beneficiation after the causes of failure are recognized and well known, but at the same time we learn by experience and it may not be out of place to remember a few reasons which have contributed to these failures.

It may seem unnecessary to state that unless the deposit of ore which is to be beneficiated can be mined for considerably less cost than a higher grade natural ore, there can be no profit in the undertaking. For instance, a ten foot vein of merchantable ore mined at a cost of $3.00 per ton might prove profitable, but if portions of this vein required beneficiation such portions would require to be mined at less than half the cost of the merchantable ore.

There would be nothing gained in treating this ore to produce a beneficiated ore that was no better chemically or physically than the average Lake Superior hematites, because its market value would be no higher. In order to compete with the natural ore it must be better in every way if it is to command an appreciably higher price.

The art of concentrating magnetic ores to be a high degree of purity by means of magnetic separators has made considerable advancement in the past twenty years. The process of magnetic separation is, in itself, very cheap, costing but a few cents per ton of crude ore treated, but the cost of separation by magnetic machines is only a small part of the total cost of beneficiation. The heaviest items of cost will be the mining and comminution of the crude preparatory to separation, and the final agglomeration of the concentrate.

The cost of mining depends on so many factors that it is difficult to estimate, although it may be said that unless the crude ore can be mined on a very large scale and by the most favourable methods, the mining cost will be prohibitive.

The crushing and grinding of the crude ore present no problems that cannot be overcome by standard engineering practice, but the cost of crushing and grinding will vary inversely with the magnitude of the operations.

The separation of the magnetite from its gangue by means of magnetic separators is not only cheap, but is easily controlled and is free from those factors which usually affect the mechanical separation of other minerals.

The agglomeration of the concentrate to make it suitable for blast furnace use will be the most costly item after mining. This operation may be carried out by one of three methods,—first, briquetting; second, nodulizing; and third, sintering. Each of these processes has been demonstrated to yield a product admirably suited for blast furnace smelting, and the briquettes, nodules, and sinter have received favourable comment from furnace operators both in America and in Europe.

The briquetting of the concentrate has been practised to some extent in both Canada and the United States, but because the process required a very costly installation and was difficult to control, it rapidly lost favour in America. The nodulizing process has been very successfully applied both in Canada and the United States and has been proved less costly for an equal output of tonnage to install and to operate than the briquetting process.

The advancement made in recent year with the sintering process has, in my opinion, placed this method in front of either of the other two processes. It is much less costly to install and its operation affords a large measure of positive control. The great majority of agglomerating plants in Canada and the United States now employ the sintering process, and while the sinter does not possess all of the physical advantages of the briquettes or nodules, this is more than offset by the lower cost of production.

HEMATITE

Processes for the beneficiation of hematite ore are usually based on specific gravity methods of separation. It is true that the electro-magnetic separation of hematite ores is quite possible, but only as an experimental operation, because the cost would be prohibitive of building a magnetic separator sufficiently powerful to concentrate a hematite ore.

The specific gravity separation of hematite ores depends on several factors. First, that the gangue materials in the ore considerably lower in specific gravity than the hematite; second, that the ore is not readily slimed, i.e. broken to powder; third, that the particles of hematite can be broken free from the gangue minerals in pieces not less than 1/4 inch.

The general conditions governing cost of beneficiation of a magnetite apply in the case of hematites. The ore body should be extensive and very cheaply mined and the concentrated product must be better than the natural ores with which it will be in competition.

As far as we know at the present time, there is no large body of low-grade hematite in Ontario which offers a better or equal opportunity for beneficiation than any of the numerous magnetic ore bodies.

THE PROCESS OF CONVERTING HEMATITE TO MAGNETITE

There are several localities in Ontario wherein are found impure hematite ores of non-marketable value, and it has been proved that these ores may be treated by a reduction process, converting the hematite to magnetite, and subsequently concentrating the artificial magnetite oxide by means of separators.

The proposal is by no means a new one and much information regarding this process may be gained by consulting a paper by Mr. Wm. B. Phillips, published in volume XXV of the Transactions of the American Institute of Mining Engineers.

Mr. Phillips has shown that, given the proper conditions of reduction, there is no difficulty in changing the hematite to magnetite, and moreover conducting the process on a considerable scale. In his article Mr. Phillips states that a ton of magnetic concentrate costing $1.25 can be produced from three tons of crude on the assumption that a ton of crude can be mined for 25c and that 50c will cover cost of reduction, crushing and magnetic separation of the three to produce a ton of concentrate.

The idea was never successfully applied even in the Southern States under the most favourable mining costs, and, therefore, would hardly be applicable to our more costly operating conditions in Ontario.

THE BENEFICIATION OF SIDERITE

The Algoma Steel Corporation has conducted large-scale operations for some years with the siderite ore of the Magpie Mine, and has demonstrated that it is possible to produce a roasted siderite containing approximately 50 per cent. iron and 9 per cent. silica. The

phosphorus content at 0.012 per cent. is well within the desired limit, but the sulphur content at 0.175 per cent. is higher than is desirable. The roasted ore is stated to be self-fluxing because of its relatively high content of lime and magnesia. If it were possible to eliminate a larger portion of the sulphur in the roasting process, the product would be more valuable.

There is said to be a much higher tonnage of siderite ore at the old Helen Mine than has been so far proved at the Magpie, and if the expenses of mining and roasting the crude can be kept within commercial limits, the treatment of both the Magpie and the Helen siderite would mean the production of a large tonnage of Bessemer ore of fair quality.

The self-fluxing quality of these roasted ores is an advantage only under certain circumstances affecting the cost of limestone flux at the furnace. If the furnaceman can buy a hundred tons of 50 per cent. self-fluxing roasted siderite for a certain sum of money and finds that he can buy a hundred tons of 60 per cent. ore together with sufficient limestone flux for the same sum, he will naturally select the richer ore.

The Algoma Steel Corporation have made considerable progress in the beneficiation of siderite ore, and their persistence in making use of these native ores is highly commendable and should be encouraged. I am of the opinion that if the sulphur in the raw ore can be eliminated to a larger extent than they have so far succeeded in doing, either by improved methods of nodulizing or by the adoption of the sintering process, that a much larger tonnage of roasted siderite could be marketed in Ontario.

METALIZING OR PARTIAL REDUCTION OF IRON ORES

Various attempts have been made in the beneficiation of low-grade iron ores to produce what is called iron sponge or metallized ore by a process of partial reduction carried on either in a rotating tubular kiln or in a long tunnel furnace through which the ore is carried in suitable receptacles.

These processes aimed at producing a semi-metallic product which, after cooling and crushing to free the metallic particles, would be amenable to separation by magnetic machines. The separated metallic concentrate would then be available for smelting in a blast furnace.

The experimenters with these various processes have been metallurgically successful in the production of granulated or spongy iron from ores, but the commercial practicability of the undertaking has never been demonstrated. It is extremely doubtful whether these processes could be made apply with any degree of commercial success to our low-grade ores of Ontario.

Briefly summarizing the problem of beneficiation, the conditions for successful operation in competition with natural ores may be stated as follows:—

(1) The ore deposit must be of sufficient size and its location convenient to rail and water transportation to admit of very cheap mining on a considerable scale.

(2) The physical and chemical characteristics must be such that beneficiation will result in the production of a concentrate that is higher in iron and lower in slag-forming elements than the average natural ores.

(3) The agglomerated product must conform to certain physical and chemical standards required by the furnace operator, which are, strength and porosity and freedom from excess of iron silicate.

(4) The concentrated and agglomerated product must be produced at a cost that will permit of its competition with natural ores in the open market.

It is of interest to note that the Mesabi Iron Company, of Babbitt, Minn., believe that they possess all of the above favourable conditions for the production of a beneficiated ore from a crude magnetite containing between 20 and 30 per cent. of iron. The operations of this Company will, therefore, prove of considerable interest to Canadians.

SMELTING OF TITANIFEROUS MAGNETITE

A large amount of experimental work has been done on the smelting of titaniferous magnetite, and it has been shown that given proper conditions of slag composition, there is no great difficulty in manufacturing pig iron from ores containing as much as 6 per cent. titanic acid, although it has not been proved that foundry iron can be made with this amount of titania in the mixture. The pig iron produced from ores containing as much as 6 per cent. titania is usually white or low silica iron owing to the necessity for operating the furnace at a lower temperature than would be required in the manufacture of foundry iron.

Any experiments with the smelting of titanic ores must necessarily be conducted in a blast-furnace, on a large scale, if valuable deductions are to be obtained. The smelting of small amounts of titanic ore in a laboratory furnace, while undoubtedly interesting, cannot duplicate the conditions under which a blast-furnace is operated and the results obtained are apt to be misleading.

Experimental smelting of titanic ores in a modern blast-furnace is a very costly business, and I am of the opinion that this problem will receive very little serious attention from blast-furnace operators until the supplies of all other ores are not readily available.

ELECTRIC SMELTING

Some years ago the prospects appeared bright for the smelting of iron ores in Ontario by means of the electric furnace.

The early experiences at Sault Ste. Marie and at Welland lead to the belief that under certain favourable conditions we might expect the electric furnace to compete with the blast furnace. These conditions were and are:—

1st: Very cheap electric power.
2nd: Expensive coke and other fuel.
3rd: A supply of cheap and comparatively high-grade iron ore.

All of the above conditions are met with in Sweden and Norway, but up to the present time these conditions have not been duplicated in Canada or the United States.

During the war and for a short time afterwards it was found practicable to manufacture a desirable brand of low-phosphorus pig iron in the electric furnace. The melting stock consisted of low-phosphorus steel turnings and the operation consisted of simply melting these turnings and carbonizing the molten metal by the addition of coke or other carbonaceous material The process was not smelting, as we understand that term, and the amount of slag made was negligible.

The melting of steel turnings and their conversion to pig iron in the electric furnace proved commercially successful as long as the low-phosphorus pig iron commanded a price of over \$60. a ton but as soon as the market price of the pig iron fell below \$50. a ton the operation was not profitable.

Keeping this fact before us, it is clear that if we substitute a 65 per cent. iron ore with its slag forming constituents for the 99 per cent. steel turnings, and with

the market price for low-phosphorus pig iron at $30. a ton, there is no prospect for commercial electric smelting of iron ore *unless* electric power can be obtained for something less than $10. per h.p. year or until the blast furnace operator is forced to pay something over $15. a ton for his coke.

CONCLUSIONS

Reviewing the whole problem in the light of past experience, we can make the following general observations, which appear to be the governing factors affecting the utilization of Ontario iron ores.

Raw Material

(1) We have at present no known deposit of merchantable iron ore sufficiently attractive to induce capital to undertake its development.

(2) We have large bodies of both low-grade magnetite and siderite ores which we know can be beneficiated to a merchantable grade.

(3) The utilization of our low grade hematites and titaniferous magnetites does not look attractive because the art of beneficiation of these ores has not, as yet, reached a successful stage.

(4) Our deposits of bog ore are negligible and need not be considered from the standpoint of tonnage production.

Beneficiation

(5) Of the various processes described there are only two which merit serious attention at present, i.e. magnetic separation, and calcining of siderites.

Smelting

(6) There is no immediate prospect that the cost of electric power will be reduced low enough to admit of electric smelting, nor is there any immediate prospect that the cost of coke or other fuel will advance to a point which will admit of the electric furnace competing with the blast furnace, at the present cost of electric power. It may, therefore, be assumed that the blast furnace will remain the only practicable smelting agency for some time to come.

Government Assistance

A review of the bounties paid by the Ontario and Canadian Governments indicates that the iron industry in Ontario has received a large measure of Government assistance in the past, although not sufficient to offset the amounts that might have been expended in Canada for labour and supplies had the Ontario furnaces been supplied with domestic ores.

It is generally recognized that if the iron industries of the Dominion had not been assisted and built up by the Government bounties in the past, these industries would not have been in a position to meet the extraordinary demands for iron and steel during the war, and that Canada could not have developed as an important factor in munition supplies.

As a National Policy the old bounty systems were undoubtedly wise precautions, because the country was enabled thereby to produce its full quota of iron and steel so necessary for the successful prosecution of the war, and the business resulting from Canadian supplies of iron and steel during the war period was in amount vastly greater than the comparatively few millions expended in bounties.

The country, while not exhausted by its war effort, is nevertheless impoverished to a considerable extent, and all Canadians are demanding the practice of the strictest economy on the part of the Federal and Provincial Governments. Under these circumstances, it would be difficult for any Canadian Government, Federal or Provincial, to convince the electorate that a new system of iron bounties is necessary, even from the standpoint of a National Policy in preparation for future wars. Whether the adoption of new bounties can be urged from a strictly economic point is a debatable point, and very convincing arguments would have to be presented in justification of an iron bounty at the present time. Those who are advocating a renewal of the bounty system should, therefore, be prepared to show conclusively that under the present adnormal conditions there would be an improvement in business generally. In other words, it must be shown that our blast furnaces will use native ores to at least 75 per cent. of their capacity, and that any surplus would find a ready export market. Only in this way will a Government be convinced that stimulation of native iron mining will result in the distribution of large sums of money for both labour and supplies. There is no guarantee at present that Canadian furnaces will or can use a large tonnage of native ore, nor could that guarantee be expected until there is a decided change for the better in the iron and steel markets of the world.

A Practical Suggestion

I am of the opinion that the only logical measure of assistance to be expected of a Government at the present time is in more extensive geological exploration. Neither the Federal nor the Ontario Government have ever made a detailed study of our iron ore resources under the direction of experts specially trained as iron ore geologists. It is true that a large amount of geological work an various iron ranges has been accomplished, but this work has always been of more or less intermittent character and the geologists employed may have worked one year on the iron ranges, devoted the next year to the silver fields and the third to the nickel ranges.

The known iron ranges of Ontario cover a very large area and the unexplored regions of Northern Ontario cover a much larger area. If we cannot find merchantable ore in our known ranges, is it beyond possibility that we may discover merchantable ore in the unexplored regions?. I believe that a corps of trained geologists working steadily for five or ten years over both the known and unknown areas of Ontario would would be of incalculable benefit, and if their work could be supplemented with a generous measure of diamond drilling carried out under their direction, I believe that our iron ore problem would disappear in perhaps ten years time.

I would, therefore, propose that a Committee of Geologists from both the Federal and Ontario Departments be appointed to consider the practicability of more extensive geological study of our known iron ranges, and to report on the possibility that systematic exploration over new areas might disclose valuable bodies of merchantable ore.

ELECTROLYTIC IRON AT TRAIL

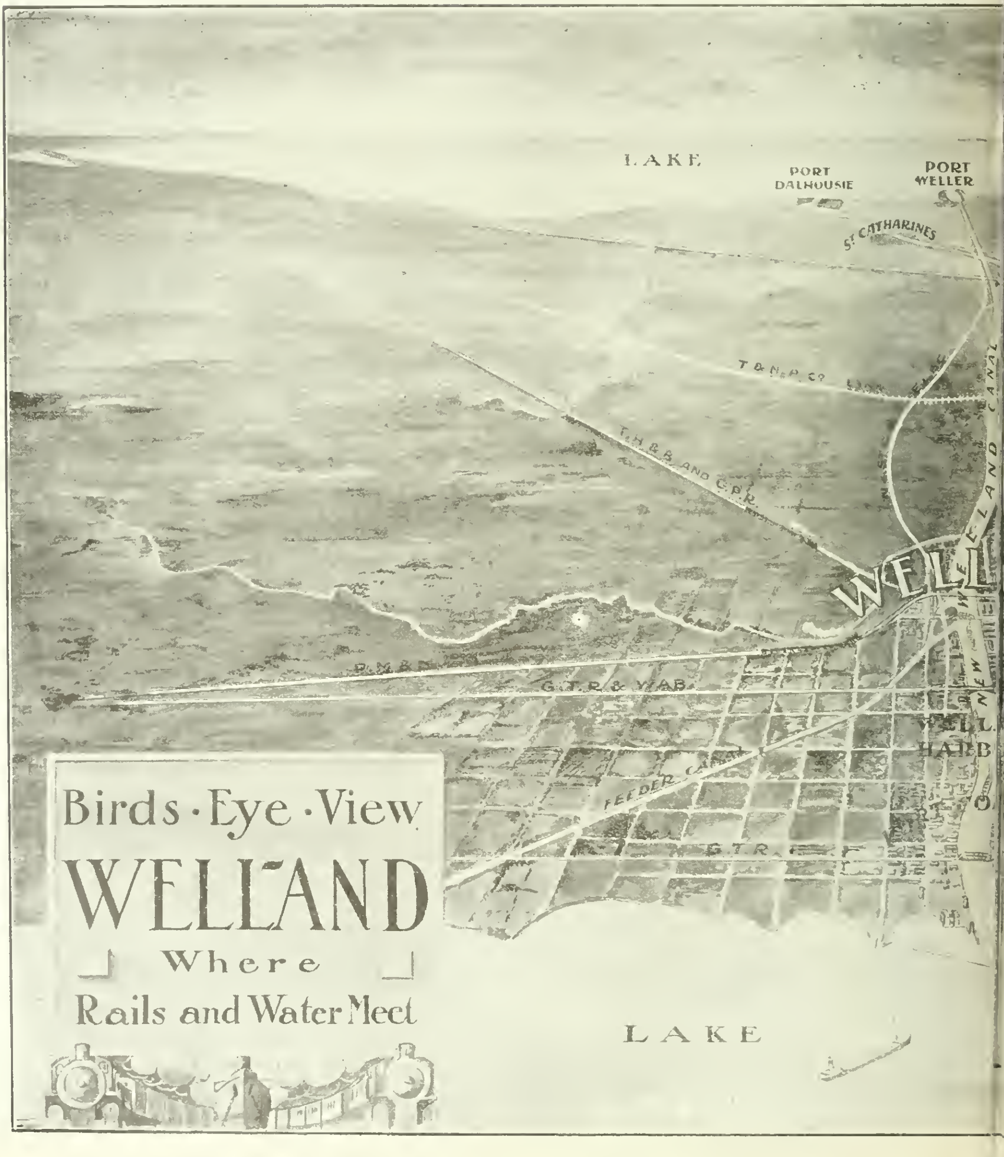
S. G. Blaylock, general manager of the Consolidated Mining & Smelting Co., has stated that in the labnouncements of the Convention, stating that in the laboratory of his Company high grade iron had been made from pyrrhotic gangue from the ore of the Sullivan Mine. An electrolytic process had been suggested by Mr. Nichol Thompson, of Vancouver. This product, which Mr. Blaylock called a stainless iron, could be rolled cold to the thousandth part of an inch and then folded over like paper fifty times. It was the purest form known, and if the Company could develop the process commercially it would be getting out of the ore of the Sullivan mine "about everything but the squeal."

COMPARISON OF WELLAND'S MANUFACTURED PRODUCTS

1906	$ 150,,000
1912	6,500,000
1915	13,285,495
1916	19,375,115
1917	28,642,390
1918	35,400,340

WELLAND AS A CENTRE OF TH

By virtue of its central location, its position on th to the largest source of electric power on the American important centre for the manufacture and fabricatin Canal, of 25 foot draft, is completed, the present adva much enhanced. The new power plant at Chippewa bulk at reasonable rates. Always there will be off-pea used for certain electro-thermic and electrolytic proce a minimum in Ontario.



IRON and STEEL INDUSTRIES

'elland canal and numerous railways, and its nearness ntinent, Welland has of late years developed into an ' iron and steel products. When the new Welland e to the city due to water transportation will be provide, for a number of years, power for use in wer available at low rates, which can be economically . Coal can be landed in Welland at a price that is

PAY ROLL COMPARISON OF WELLAND'S INDUSTRIAL WORKERS

1906	$ 50,000
1912	1,300,000
1915	2,117,618
1916	3,610,336
1917	5,569,190
1918	5,466,221

Welland's Iron and Steel Industries

CANADIAN ATLAS CRUCIBLE STEEL CO., LTD.

Many of the industries of Welland are concerned with the manufacture of iron and steel and its products. Prominent among these is that of the Canadian Atlas Crucible Steel Co., Ltd., manufacturers of tool steels, which has its main office and works at Welland. The company, which may be said to be an offshoot of the Atlas Crucible Steel Co., of Dunkirk, N. Y., was incorporated in May 1918, and took over another already existing plant as part of its plant and also erected substantial additional buildings. The site covers 6 acres and the buildings of the plant comprise the following: a Melting department 80 ft. x 100 ft. containing one thirty pot crucible furnace and a gas producing plant for operating the furnace; a Hammer department 80 ft. x 160 ft. which contains one 4 ton hammer, one 2 ton hammer, one 1½ ton hammer, one 1 ton hammer, one half ton hammer, and a 600 pound tilting hammer; and also contains the necessary furnace, for each hammer; a Grinding department in the same building as the Hammer department; a Rolling department 80 ft. x 100 ft. with a mill motor including the necessary heating furnaces and roll turning equipment; a Boiler house 35 ft. x 40 ft. containing two 150 H. P. boilers; an annealing department 60 ft. x 80 ft. containing two annealing furnaces; an inspection and Shipping department 60 ft. x 40 ft. the equipments of which consists of power hack saws and straightening and grinding equipment etc., a warehouse 60 ft. x85 ft. with steel storage on the first floor and also the mill office and on the second floor miscellaneous stores and the general office. The products of the plant consist of tool steels, high-speed steels, alloy steels, hollow mining, drill steel, and various shapes such as axe-bit, lawn mower and so forth. Steel is produced in the plant of the Canadian Atlas Crucible Steel Co., by the use of the very best of modern equipment. Working conditions and quarters are as desirable and attractive as possible, and this act results in the insuring of the highest possible efficiency in placing at the disposal of the company's customers, quality products. It should be added that the company's mechanical, chemical and metallurgical engineers are always at the service of its customers.

CANADIAN STEEL FOUNDRIES, LTD.

Important Subsidiary of Canadian Car and Foundry Co.

It is well known that Welland is a very considerable center of the steel and iron industry. As such it is quite fitting that the great national concern, the Canadian Car and Foundry Company, Ltd., should be represented in its midst, as it is, by the large and splendidly equipped works of the Steel Foundries, Ltd., consisting of a steel foundry and rolling mills. Shortly after the formation of the Canadian Car & Foundry Company, Limited, which was incorporated in 1909, it became apparent that arrangements would have to be made for its requirements of steel castings, which were becoming more and more important in connection with car construction, and in order to control the supply of this necessary material it was decided, early in 1911, to secure the properties of the Montreal Steel Works, Limited, and the Ontario Iron & Steel Company, Limited, of Welland. At that time the Montreal Steel Works were the larget producers of steel castings in Canada and, besides their original plant adjacent to the Lachine Canal at Point St. Charles, they had commenced the erection of a modern steel castings plant in Maisonneuve, now known as the Longue Point Plant. The Ontario Iron & Steel Company had located adjacent to the Welland ship canal. These three properties were amalgamated and now compose the Subsidiary Company, Canadian Steel Foundries, Limited.

The Canadian Car and Foundry Company, which owns and operates the Canadian Steel Foundries, Ltd., is one of the country's foremost Industries, its capital stock and outstanding bonds aggregating $20,000,000.00, while its total assets exceed $30,000,000.00. Under general conditions its employees number between 8,000 and 9,000, and its annual payroll $4,500,000.00 to $5,000,000.00, but, in addition, owing to its many ramifications, it is estimated that fully 30,000 people are directly dependent upon the Company for their living necessities, its annual purchases of all kinds during normal periods amounting to between $15,000,000.00 and $20,000,000.00. The Head Offices are located in the Transportation Building, at Montreal, and there is an influential Board of Directors comprising the following:

Montreal: The Hon. N. Curry, Chairman of the Board, W. W. Butler, President, W. F. Angus, Vice-President, H. W. Beauclerk, the Hon. C. P. Beaubien, Francis H. Clergue, V. M. Drury, Wm. McMaster, Mark Workman.

New York: Lewis L. Clarke, Andrew Fletcher, A. Hicks Lawrence, W. H. Woodin, and the Hon. E. C. Smith of St. Albans Vt.

LACKAWANNA TUBES, LTD.

Among the industries which are destined to loom large in the manufacturing life of Welland in the not distant future that of Lackawanna Tubes, Ltd., which has been incorporated with an authorized capital of $525,000 to take over the properties of the Welland Machine and Foundries Ltd., must take a foremost place. The concern's capital is all American, but the company is absolutely independent and neither subsidiary nor ancillary to any other. The main production of the plant will be seamless steel tubes from ½ inch to 6⅝ inches O. D.. All types of mechanical tubing used in the automobile industry will be produced as also all types of boiler tubing. This will be the only plant in the Dominion producing such tubes, as hitherto it has been customary to import them from the United States.

The plant, which will represent an absolute cash investment, will be the most modern of the smaller plants on this continent. The old foundry is being repaired and put in first-class shape, while a new main building, 80 ft. by 400 ft., is now being built. The

Robertson process of Sarnia is now being used on the roof of this building, and the side-walls are 5 ft. brick and continuous sash up to 27 ft. The other buildings at present include a foundry building, and a good-sized wood working and pattern shop. A separate brass foundry building is already constructed and a separate machine shop for the foundry alone is now being built. The approximate capacity of the plant when complete will be 30,000 tons, and, when full production is attained, the employees will number about 250.

Mr. L. R. Weeks, of New York, is the President of Lackawanna Tubes, Ltd., and the active management of the concern is in his extremely capable hands. It may perhaps be added that a great deal of the stock in this company is owned by a holding company which holds stock in other steel companies. In conversation with a representative of *Iron and Steel of Canada* Mr. Weeks stated that he was convinced that manufacturing costs in Welland were very much cheaper than in the United States. He added that the primary reasons for the company with which he is identified locating at Welland were the facilities for the export market together with the great wealth of water power in the locality. The decision of Lackawanna Tubes, Ltd., to locate at Welland is an outstanding example of the realization by the most alert and astute capitalists in the United States of the present very favorable opportunity for United States capital to invest in Canadian industry. The large increase in the establishment of factories in Canada capitalized in the United States has been very notable recently. Nearly all of them have done well. And unless one much misjudges the omens, Lackawanna Tubes, Ltd., is destined to present a very remarkable example of sound, yet rapid, industrial expansion.

CANADA FOUNDRIES AND FORGINGS LTD.

One of the most important industries located at Welland is the Canadian Foundries and Forgings, which operates two plants, both extensively engaged in the Forging business.

At their Canada Forge Plant, heavy Steel Forgings of every size, shape and weight are turned out, amongst which might be mentioned Marine Forgings, Railroad Axles, Dredge equipment, Forgings for Gas Engines, Hydraulic Machinery, Locomotives, Metal Working machinery, Mining, Pulp Mill, Rolling Mill equipment. Single Forgings up to 40,000 lbs. have been turned out and machined at this Plant, where they possess Forging and Machining facilities second to none in Canada.

Their Endurance Brand Crusher Balls are standard in all mining districts and are largely used throughout Canada wherever Ball Mills are installed.

This plant was one of the first and largest producers of Shell Forgings throughout the entire course of the War and were also very heavy producers of Marine Forgings for use in shipyards, both in the United States and Canada, when shipbuilding was at its height during recent years.

The Drop Forge Plant of the Canada Foundries and Forgings, also situated at Welland, is one of the most up-to-date Plants of its kind in Canada and has enjoyed for a number of years a very large volume of business in Drop Forgings of every description.

They have been, during the last few years, especially busy in producing the larger Drop Forgings used on Automobiles, such as front axles, crank shafts, third arms, etc. and have been doing their share in bringing about the production of Motor Cars made entirely in the Dominion of Canada.

In addition to a general commercial Drop Forging business, they also produce a line of staple stock articles, such as Wrenches of all descriptions, Turnbuckles, Journal Box Wedges, etc.

Both these Plants have run continuously during recent dull times and report that before long they will return to times of normal production.

In addition to these plants, the Canada Foundries and Forgings own and operate the James Smart Plant at Brockville, Ontario, where for over half a century, staple hardware articles have been turned out, and whose name is a household word throughout Canada.

The officers of the Canada Foundries and Forgings are: President—W. M. Weir, Montreal; Vice president—Hon. Geo. P. Graham, Ottawa; General Manager—James Arnold, Brockville; Secretary-Treasurer—J. H. A. Briggs, Brockville.

THE VOLTA MANUFACTURING CO. LTD.

Among the industries of interest and importance located at Welland is the Volta Manufacturing Company, manufacturers of electric steel and iron furnaces; ferro silicon furnaces; ferro-alloy electric furnaces for melting copper, brass, zinc and aluminum; furnaces for melting Babbitt; electrode winches; automatic regulators; hand controllers; current transformers; electrode holders coolers and special machinery of all kinds.

Mr. J. Young is President of the Company, Mr. Robert Turnbull, Vice-President and Mr. Chas. W. Sim, Secretary and Treasurer. The company, whose plant is in first rate shape and equipped with all the latest machinery for the manufacture of its various lines, has installed a large number of furnaces in Canada and the United States and abroad. During the war it supplied over 90 per cent. of the special electrical equipment for electric furnaces used on all types of furnaces on this continent.

The Volta Manufacturing Company has recently perfected an electric furnace for heating soldering coppers which has come through a highly satisfactory test in a radiator plant. In a report on this test it is pointed out that the consumption is only about 840 watts per hour and that 1,200 degrees are required to heat the iron. It takes from a half to three-quarters of an hour to heat up to the required temperature for 1½ in. coppers and three minutes to heat a pair of coppers after the furnace is hot. As the dressing and cleaning of coppers are no small items it is of great importance that this be done with an electric furnace in about half the time required by gas. Working conditions in the vicinity are greatly improved since the heat is almost entirely eliminated and there are no noxious gases. The cost is also slightly in favor of the electric furnace and the plant in question is making a complete installation of twelve furnaces.

The Executive of the Volta Manufacturing Company is composed of men who have been associated with the development of the electric furnace industry in its many forms since its first inception on this continent. Those who deal with it, therefore, may rest assured that in purchasing apparatus from the Volta Manufacturing Company they will be getting the best that is to be had in this line. The company's engineers are at their disposal at

any time to advise as to the equipment that would be most suitable to meet requirements under existing local conditions.

PAGE-HERSEY TUBES, Ltd.

One of the very foremost of Welland's industries is that of Page Hersey Tubes, Ltd., manufacturers of wrought tubular products. This large concern which has its head office in Toronto, and, in addition to its Welland Mills, has mills also at Guelph, and at Cohoes, N.Y., and warehouses at Welland, Guelph, Montreal and London, Eng., was among the very first industrial undertakings to start operations in Welland, locating there in the year 1907. Its products, which are all of both steel and wrought iron, include a full line of tubular goods for all purposes. The trade done by Page-Hersey Tubes, Ltd., is world-wide, extending to all the British Dominions, as well as to South America and the Orient.

The mill at Welland, which is in splendid shape, consists of two main buildings about 250 ft., by 150 ft. There is a fine store-house some 600 ft. by 60 ft. in dimensions. The mill has its own galvanizing plant and machine shop, while there is a forge building for pipe couplings. The machinery is all of the most modern and approved type — in fact the last word in mechanical excellence — and all machines are equipped with individual motors, to the number of 160 in all. Exceptional facilities, in the shape of seven electric traveling cranes, are in use. The production at the plant averages about 60,000 tons a year. Just now it is exceptionally busy, running, in fact, day and night. It employs some 500 men. Mr. A. M. Mosley is the general works and plant manager.

It has added not a little to the industrial prestige of Welland to have located in its midst a concern of such magnitude and high standing.

ELECTRO METALS, Ltd.

The Electro Metals Ltd., of which concern Col. L. C. Raymond is president; Mr. Walter Easton vice-president, general manager and treasurer; Mr. N. Z. Marshall, secretary; and Mr. E. Darte, works manager; has a fine plant at Welland where it manufactures ferro-silicon from 10 per cent. to 90 per cent. which is used extensively for refining steel and also all ferro-alloys such as ferro-silicon manganese, low phosphorous pig-iron, carbon electrodes for electro furnaces and so forth. Its output counted in 50 per cent. ferro-silicon is about 10,000 tons per year. The plant which is equipped with the most up-to-date machinery, much of it of a necessarily intricate and expensive kind, stands on a site of about 25 acres. The plant is admirably adapted for the purpose of manufacturing the products named. The furnace room is 80 feet by 600 feet in size and the electrode plant is 120 feet by 560 feet. The works are at present using 11,000 H. P. but the total capacity of the plant is up to 50,000 H. P. The company operates its own quarries which are located at Killarney, Ont., in the Georgian Bay district and the material is shipped direct by boat to the docks of the plant. The presence in its midst, of a concern not only with such present performance to its credit, but also with possibilities of such magnitude ahead of it, is, as universally recognized in Welland, adding very greatly to the industrial prestige of the city.

STANDARD STEEL CONSTRUCTION CO., Ltd.

The Standard Steel Construction Company, Ltd., has a big plant and warehouse in Welland. Here large quantities of steel are held in stock for immediate shipment. All kinds of structural steel are included in the output of this concern which is an offshoot of the well-known steel fabrication organization at Pittsburgh.

CANADIAN MEAD-MORRISON CO., Ltd.

Among the well-known manufacturers established in Canada that have taken up the manufacture of machinery for pulp and paper plants is the Canadian Mead-Morrison Company, Limited, who, at their factory at Welland, Ontario, have already built for the Canadian trade a large number of Wood Room Machines such as Barkers, Splitters, Chippers, Chip Crushers and Chip Screens. This line of Wood Room Machinery formerly made in the United States is well known to the pulp and paper manufacturers as it has been in most successful use by them for many years, and it is pleasing, of course, to know that another concern is making such machines in Canada, thereby accomplishing the double purpose of saving money and giving employment to Canadians.

Quite recently the Canadian Mead-Morrison Co., Ltd., has brought out a new and larger capacity Chip Crusher and a Shaker Chip Screen, both of which embody notable improvements.

In addition the "Mead-Morrison" line of Power House equipment such as Skip Hoists, Weigh Larrys and Conveyors, has been installed in a number of plants, among the more recent of which might be mentioned the skip hoist and weight larry equipments for the new boiler house at the Brompton Pulp and Paper Company's plant at East Angus, Que.

BRITISH EMPIRE CUTLERY CORPORATION

The British Empire Cutlery Coporation capitalized at $1,000,000 has acquired an option on a plant in Welland formerly owned by Fulton Motors Ltd. The intention is to begin operations almost immediately when the corporation will manufacture a full line of cutlery of all kinds for domestic and export trade.

THE WABANA ORE AGREEMENT A CORRECTION

Our attention has been called by Mr. R. M. Wolvin, President of the British Empire Steel Corporation, to the fact that the statement on p. 121 of the July issue of *Iron and Steel of Canada* is not correct. The agreement with the Newfoundland government, as quoted in the volume on the iron ore of British America recently issued by the Imperial Mineral Resources Bureau, includes the following provisions:—

All ore shipped to Nova Scotia shall pay an export tax of 25 cents per ton. If the annual shipment to Nova Scotia is a million tons or over, ore may be shipped to other points in Canada without tax; if less than a million tons, the tax of 25 cents shall be paid up to a million tons.

Ore may be shipped free of tax to countries other than Canada, provided the company spend three million dolars during the next five years on improvements and developments in their plants, and that they give notice before January 1st 1926, of their intention to erect in Newfoundland a smelting plant of 100,000 tons annual capacity, else a tax of 10 cents per ton will be levied on such ore.

BOOK REVIEWS

IRON ORE.- Part 1.—United Kingdom. — Imperial Mineral Resources Bureau. 6s. 5d., post free, from H. M. Stationery office, Imperial House, Kingsway, London, W. C. 2.—237 pp.

The sub-title of this volume, "Summary of Information as to the Present and Prospective Iron-ore Supplies of the World," indicates the scope of the series of which this is Part 1. Succeeding volumes deal with British Africa, British America, British Asia, and the British Pacific regions; then foreign countries in Europe and Africa, America, and Asia and the Pacific, respectively. The total of eight volumes will form a veritable encyclopaedia of information about iron ore, with the emphasis placed upon deposits in British territory.

As explained in the introduction to this first volume, the scope of the inquiry of the Bureau has been considerably widened in the case of iron ore at the request of the National Federation of Iron and Steel Manufacturers of Britain, who have provided the additional funds required for this further inquiry. This, by the way, would seem to be a clear indication of the trend of thought of those business men of Britain who are engaged in the iron and steel business. They would hardly care to invest in the compilation of information such as this unless they wished to follow up the investment, and the logical conclusion is that they wish, not only to examine closely the relative position of Britain in world production, but to obtain reliable information as to the possibility of extending their smelting operations throughout the Empire.

The major part of the present volume is devoted to a discussion of the modes of occurrence of iron ore in the United Kingdom, and descriptions of individual beds and deposits. As a preliminary, the nature of iron ores throughout the world is briefly discussed, their geological ages, beneficiation, and the various chief factors determining their economic value.

The mainstay of the iron-ore production of Britain, as of France, is bedded deposits of Jurassic age, characteristically high in phosphorus and rather low in iron, but self-fluxing either alone or in mixture. These beds out crop near the coast and close to productive coal measures. The developed reserves, mainly comprised in the Cleveland ironstone, total 1,200 million tons, and the probable total is three times that amount.

The other important source of ore in Britain is the limestone beds of Cretaceous age, containing the hematite ores of Cumberland and Lancashire. These are non-phosphoric and higher in iron than the ironstone; but they are not so cheaply mined, nor is their extent so large. But there is still an important annual output, and the reserve determined is 45 million tons, with a probability of double that amount.

The report emphasizes the fact that the present difficulties of production of iron ore and its products in Britain are due to labour troubles and consequent high costs, and that under normal conditions Britain can hold her own, for many years to come, as one of the world's chief producers of iron ore.

IRON ORE—Part 2.—British Africa.– Imperial Mineral Resource Bureau — 3s. 3d., post free, from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2.—76 pp.

Africa is still, in the main, *terra incognita* as regards its mineral resources, including iron ore. But in the Union of South Africa a certain amount of systematic exploratory work has been done, and this has been sufficient to demonstrate that here lies one of the principal ore-reserves of the world.

Though the deposits are known to be vast, and their quality has been determined in a fairly conclusive way, still they are not yet susceptible to definite estimates of tonnage. Probabilities only can be indicated.

Here, as elsewhere, bedded deposits provide most of the ore available. The Pretoria series of rocks is estimated to contain, in the vicinity of the capital city alone, and by open-cast and adit mining, 400 million tons of ironstone ore, with an iron content of 48 per cent. Known occurrences of the same beds elsewhere bring this total to 1,000 millions.

There are numerous smaller beds and sporadic occurrences of hematite ore, all of fair grade and some of them of high grade, and it is these that are at present in use to supply the two small blast-furnaces the Union now possesses.

The great laccolith of South Africa, underlying the Bushweld, supplies one of the largest known deposits of iron ore in the world; but it is titaniferous. It occurs chiefly in flat-lying beds formed by magmatic segregation. Some of the beds are high in iron (60 per cent.), and low in phosphorus and sulphur, with about 16 per cent. titania. The quantity of this grade available has been provisionally estimated at 2,000 million tons.

It seems unlikely that any of South Africa's iron ore will be available for export as such, as its grade and the long rail hauls to the coast will prevent it. But it seems certain that, with ore, coal and fluxes conveniently available, South Africa will soon supply her domestic requirements of iron and steel, and it may be possible to build up a profitable export trade in finished and semi-finished products.

Elsewhere in British Africa the information available is incomplete and rather vague. Exploration only will improve this.

IRON ORE — Part 3. — British America, — Imperial Mineral Resources Bureau — 3s. 9½ d., post free, from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2. — 115 pp.

As with all the outlying parts of the Empire, the mineral resources of Canada, including iron ore, are as yet only imperfectly known. Consequently the present volume must be considered suggestive rather thon determinative. This is conceded in the statement in the summary that "with "the data at present available, it is impossible to estimate "even approximately the reserves of iron ore in Canada." The hope for the future is expressed in the closing sentence: "There are ample supplies of coal in the Dominion, "and most of the other materials required by steel makers "are to be found in abundance, a fact which affords a "strong incentive to search for new and suitable deposits "of iron ore."

The recent position is well indicated in the following sentences: "There are undoubtedly large resources of "iron ore in Canada, but the majority of the deposits known "at the present time consist of low-grade ores, which gen-"erally require treatment to raise them the standard of "furnace requirements . . . . . By far the larger portion "of the Dominion is practically unknown as regards its "mineral resources, and only a very small portion in the "more populated parts, along the coast and larger rivers,

has been at all prospected. Sufficient evidence, however, has been obtained to indicate the great potentialities of the unprospected areas."

The reference above to coal supplies refers, of course, to the coal measures of Nova Scotia, Alberta and British Columbia. The description of individual districts and deposits, which comprises most of the volume, contains the conclusion that there still remains a good chance for locating in each of these provinces iron-ore deposits suitable for the basis of a great iron and steel industry.

One little error, either a misprint or a quotation from a report that has now been supedseded, does injustice to one of our principal ore reserves. The Magpie and Helen Mines in Michipicoten District, Ontario, are credited with 2,000,000 tons of ore. Actually, the New Helen has proven ore to the extent of 100,000,000 tons at least, and probably much more.

For the rest of British America, British Guïana and Trinidad are almost completely unexplored, while nothing is known, officially, of iron ore in Jamaica or the Falkland Islands. Newfoundland, by virtue of its huge bedded deposits at Bell Island (Wabana) near St. Johns, has one of the largest known ore reserves in the world, estimated at about 3,500 million tons — sufficient to supply the demand of the whole world for a period of twenty years.

IRON ORE. — Part 4. — British Asia. Imperial Mineral Resources Bureau. — 2s. 8½d. post free, from H. M. Stationery Office, Iperial House, Kingsway, London, W. C. 2. 65 pp.

British Asia is comprised mainly by British India, in which occurs one of the largest known reserves of high-grade iron ore in the world. Though a comparatively short distance to the west of Calcutta, these deposits remained unexplored until recent years. At present there is being built up, with remarkable rapidity, an iron and steel industry of world importance, firmly based upon this unsurpassed source of iron ore and a neighbouring supply of coal of good quality and of fair dimensions.

The principal ore-deposits of India occur within an area of about 150 miles diameter, situated 300 miles west of Calcutta, and at an average distance of 120 miles from the coal field, which are to the north. They occur in rocks of pre Cambrian age, and are comparable with deposits of similar occurrence in the Lake Superior region, Brazil and elsewhere. Their total size is still undetermined, but one range 30 miles long in the Orissa region is estimated to contain 3,000 million tons, and the resources of the whole iron bearing area are estimated at 20,000 million tons of high grade ore, 60 per cent. or over in iron. The ore is hematite, locally altered to magnetite, and is characteristically of Bessemer grade, with only a few per cent of silica.

If only the visible supply of metallurgical coke were comparable to her known supplies of iron ore, India would be assured of an iron and steel industry of the first magnitude. But though the coal measures to the north and northwest of Calcutta are known to contain a very large supply of coal, only a small part of it is of metallurgical quality. The reserve of high grade coking coal at present determined is 2,000 million tons, which will last only a comparatively few decades, if the present rate of increase in its use be maintained. It is suggested that the use of this high grade coal be restricted to metallurgical purposes, and that the lower grade coal, of which there is an abundance, be used wherever possible.

Though its successful initiation is of only recent date, India's modern iron and steel industry is already of large dimensions. The principal producer at present is the Tata Iron and Steel Company, which now produces 900 tons of pig-iron a day and 17,500 tons of steel ingots a month, while additions at present nearing completion will raise these outputs an additional 1000 tons of pig-iron and 1000 tons of steel ingots a day. This company and its subsidiaries manufacture rails and miscellaneous rolled shapes, forgings, agricultural and industrial machinery, tin plate and enamelled utensils, wire products and pipe. In addition a plate mill has recently been completed. The Bengal Iron Company produces pig-iron and castings only, at the rate of 450 tons a day. The Indian Iron and Steel Company is erecting works to produce 600 tons of pig-iron a day. Two other companies, the Eastern Iron Company and the United Steel Corporation of Asia, are projected.

The rest of British Asia contains iron ore only in minor amount, and none of it is being used. Among Ceylon, the Malay States, Borneo, the mandatory states Mesopotamia and Palestine, and Hong Kong, only the last has an appreciable amount of ore. On the mainland portion of the Hong Kong colony a number of lenses of magnetite are known, containing several million tons of ore.

IRON ORE — Part 5. — Australia and New Zealand — Imperial Mineral Resources Bureau — 4s. 4d., post free, from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2. — 106 pp.

Prior to 1915, Australia possessed no iron smelting works of importance. The establishment in that year of the Broken Hill Proprietary Company's works at Newcastle, New South Wales, virtually initiated the iron and steel industry of the Commonwealth, which is now (barring incidental labour troubles) in a very sound position. The Newcastle works are capable of producing 1,500 tons of pig-iron a day, and comprise as well basic open-hearth steel furnaces, rolling mills, merchant mills, and foundry and forging plants. Another works at Lithgow has a capacity of 3,000 tons of pig-iron a week, and a steel works in addition. The Australian Electric Steel Company, Limited, has been successful in producing steel in electric furnaces.

As the practical interest in Australia's iron ore deposits is of such recent date, not much is known of them, and that little mainly on the south coast, the interior and northern (tropical) parts being virtually unprospected so far as iron ore is concerned. At intervals along the coasts of each of the states (with the exception of Victoria) ore deposits of considerable magnitude and satisfactory grade have been found, the total known reserve being 345 million tons. The most important deposits up to the present are on the islands of Yampi Sound, in Western Australia, and at Iron Knob, in South Australia. The Yampi Sound deposits are huge beds of compact hematite, interbedded with highly metamorphosed sedimentary rocks. The Iron Knob deposits are large lenses averaging 68.5 per cent iron, which at present supply the iron works at Newcastle.

Coal of metallurgical grade is also readily obtainable on the south coast of Australia; so the conclusion that "the "resources of Australia appear to be adequate for the "establishment of an iron and steel industry capable of "supplying the local demands and providing a surplus "for export," would appear to be well justified.

New Zealand is not so well supplied with iron ore as is her larger neighbour. The principal deposit known is at Parapara near the northwest corner of the South Island. Here there has been determined 65 million tons of limonite of fair quality, locally called Onakaka ore. There

are extensive deposits of titaniferous iron sand on the north Island, and an unsuccessful attempt has been made to smelt it by a new method. Lately the plant so used has been purchased for removal to the Onakaka ore beds where the limonite will be smelted. The lack of suitable coking coal has militated against the successful establishment of an iron smelting industry.

* * *

One small item is lacking in these reports merely a convenience, but one that the reviewer has missed. The sketch maps accompanying all the volumes have no scale of miles. This might logically be included in future volumes.

THE METALLURGY OF IRON AND STEEL by R. E. Neale, editor of Pitman's Technical Primers — 122 pp., illustrated, 2s. 6d. net. Sir Issaac Pitman & Sons, Ltd., London, Melbourne, Toronto and New York.

This little volume is compiled mainly from the papers of Sir Robert Hadfield, whose eminence in the field of ferrous metallurgy is equalled only by the enthusiasm he inspires in his host of assistants, co-workers and friends.

The key-note of the little treatise is "conservation"— economy of materials, time and expense being brought out in various settings. As is natural under the circumstances under which the book was written, and as is eminently pertinent at the present time, the subject of alloy steels is treated at some length. A rapid view is given of the history of steel manufacture and of the processes chiefly in use today. Particular emphasis is laid upon the value of research, and the necessity for continuous and well-directed effort along this line of human endeavour.

In the June issue of *Iron and Steel of Canada,* there appeared an abstract of Sir Robert Hadfield's address, now published in pamphlet form as *The Work and Position of the Metallurgical Chemist.* This volume can be obtained from the publishers, Messrs. Charles Griffin & Co., Ltd., 12 Exeter Street, Strand, London, W.C.

SAFETY WORK AT THE "SOO" PLANTS

By Frank J. McGue.

The staff of the Coke Oven Department of the Algoma Steel corporation, Sault Ste Marie, Canada, has been endeavoring to make a little record in Safety operation of coke ovens. During a period of ten months, from the 15th of September, 1921, until the 15th of July, 1922, the ovens have been operated with but one lost time accident.

The Algoma Steel Corporation has for the past twenty months been carrying on an intensive safety campaign, on purely psychological lines, the theory underlying the campaign being that industrial accidents are, to the extent of 95%, basically caused through a failure of the human element. Publicity alone has been used to arouse all employees to such a point that they will be keenly intrested in safety. This point having been reached, after a year's campaign of publicity, safety committes were formed in all departments and the safety proposition was placed entirely and exclusively in the hands of the men on the job. This system has resulted in the development of the initiative of all workingmen, with the result that accidents have been decreaseed roughly, 65%, with a decrease in lost time of, say, 75% and a decrease in compensation cost of accidents of about 80%.

In the period mentioned the coke ovens screened, crushed conveyed and loaded over 600,000 tons of coal and coke and also handled 2,000,000 gallons of tar and in the neighborhood of 400,000 gallons of sulphuric acid. The dangers of operation cover practically all the hazards to be found in all other manufacturing lines combined. To enumerate a few,

Transportation — electric locomotive and quencher cars; lorry cars and pushers travelling up and down the batteries practically all the time; steam locomotives switching empty and loaded cars in and out of the plant.

Power Transmission — consisting of belts, gears and cables.

Moving Materials — by belts and bucket elevator.

Platform Elevators — Two.

Materials under Pressure — Steam, air water, gas tar, ammoniacal liquor and acid.

Electrical — practically evething electrically driven, using D. C., 250 V., and 220 V., and 2300 V., A. C. currents.

Moving Equipment — steam engines and fly wheels, pumps and machine shop equipment.

Burns — include fire, steam, acid, lime tar and electrical

Sore Eyes — caused by coal and coke dust, electrical flashes and splashes of tar, ammoniacal liquor and sulphuric acid.

The above list, considered with the ordinary, everyday flashes and splashes of tar, ammoniacal and sulphuric falling off platforms, etc., and the fact that there has been only one lost time accident during the past ten months, proves the results that can be obtained from continued study and practice of "Safety First" methods.

CANADA AND CARDIFF

Cardiff, the market city of a wealthy industrial area and the world's great Coal Port, is particularly desirous of developing a direct trade with Canada, and is determined to let no obstacle prevent its accomplishment. Canada and Cardiff are already linked up by regular direct sailings, and arteries of rails and highways lead from the Port to all parts of Great Britain.

To further aid the quick transmission of business, the Imperial Cable Department of the Post Office announce that the pre-war cable deferred service rates have been restored to the whole of Canada. Deferred telegrams between Toronto, Montreal, Quebec and other places in Eastern Canada and Cardiff only now cost $4\frac{1}{2}$d. per word, and the average time of transmission by the Imperial route is within $1\frac{1}{2}$ hours.

The Imperial is the only Atlantic cable under purely British control and worked direct from London to Halifax, N. S.

Cardiff has direct through communications with London, where expert cable operators transmit across the Atlantic, the system in operation combining speed and accuracy in working, so essential to the business man of to-day, and this specially quick service is at rates not exceeding other routes, while for certain parts of Canada the deferred rates, are $1\frac{1}{2}$d. a word cheaper.

The facilities given by the Imperial Cable should materially assist in the development of trade between the Mother Country and the Colonies, and it is interesting to note that although specially low rates are charged, the cable is making a satisfactory profit, which goes to the direct reduction of taxation. The same facilities offered by the American cable companies are also available by the Imperial route.

British Mechanical Engineers Abroad

BY ROLAND H. BRIGGS

On the Twelfth of June, 1922, a representative gathering of the Members of the Institution of Mechanical Engineers, numbering about a hundred, and fifty ladies and visitors, left London under lead of the President, Dr. H. S. Hele-Shaw, LL. D.,D. Sc.,F. R. S.for a technical and social tour in France and Belgium. The party first stopped at Amiens, and then motored through the devastated area which many readers in Canada will remember well.—Villers-Brettoneux, Rosiers, Montdidier and Compiegne. In Paris they were received with great cordiality by the French Engineering Societies, who, by their kindness and courtesy made their visit a most enjoyable one.

Engineering Works in Paris

Several important papers were read at the meetings of the Institution held in Paris, and visits were paid to the great engineering Works of the district, including the Eiffel Tower Wireless Station, the Gennevilliers Power Station, the largest in the world, the Saint-Maur Pumping Station, the Conservatoire National des Arts et Metiers, and the foundries, rolling mills and works in the neighbourhood of Paris.

The plant in the famous Eiffel Tower Station is fitted in duplicate with a sending plant for sparks of about 100 kw., a sending plant with arc of about 100 kw., a high-frequency alternator of 20 kw. (antenna), and a plant with electrode lamps and about 1 kw. power (antenna) for wireless telephone messages. The new electric generating station at Gennevilliers is to be fitted with five units of 40,000 kw. each, one of which is already installed. The station produces three-phase current at 50 periods, 6000 volts, stepped up to 60,000 volts for high-tension transmission, and distributed underground to the various sub-stations. The boiler plant is designed for a working pressure of 350 lbs. per sq. in., with the temperature of the superheated steam at from 375 to 400 deg. C., with feed water heated to 80 deg. C. at the turbines and to 100 deg. C. by the exhaust from the auxiliary machines, and leaving the economizers at 160 deg. C. to enter the boiler. The design of the station allows for its extension to take eight units, with a total output of 320,000 kw.

The great pumping station at Saint-Maur is of interest from the fact that three kinds of power are used there, namely, hydraulic, steam and producer gas. The station is capable of dealing with 4,480,000 gallons of filtered water and 29,100,000 gallons of river water per day. The largest Works visited was the Renault factory, in which 25,000 men were employed during the War. The forging shop has a daily production of 15 tons, and is equipped with 4 and 7 ton drop hammers, a 5 ton block hammer, and an 800 ton press. There are rolling mills with a guage of 400 mm. to receive iron and bars of a diameter up to 100 mm .working near a set of benches for cold rolling, the most powerful of these having a tractive effort of 70 tons. In the aluminium foundry both sand moulding and die-casting is carried out, and there are a bronze foundry and two cast iron foundries. One of the most important parts of the works is devoted to cast steel, and contains four Bessemer converters operated in alternate batteries of two, and a special department is devoted to malleable cast-iron.

Another great Works visited was the Hotchkiss Machine Gun Factory, started by the American inventor, B.B. Hotchkiss in 1871, and another was the boiler works of the French Babcock and Wilcox Company, connected with the great British firm of the same name. Many other great Works were thrown open to the Members of the Institution, including the Fonderies et Ateliers de Nord-Paris. These foundries are capable of producing an output of 1000 tons per month of ordinary or special cast iron, and they make a speciality of mottled or chilled cast iron rolling mill rolls, and of engine castings of all kinds. There are five cupolas of from 2 to 10 tons capacity, so that castings up to fifty tons in weight can be made, and there are three Bessemer converters of 1 to 2 tons, giving a a production of 300 tons of steel casting per month.

The Visit to Belgium

When the Members of the Institution reached Belgium, they found a far larger number of social and technical festivities than they could possibly attend to. Receptions by the Engineering Association of Liege, by the Burgomaster, anl by the Anglo-Belgian Club, the Opening of the Exhibition by His Majesty King Albert and of the Congress by Professor Hubert, C. B. E., and other social functions, were mingled with the technical interest of the mining and engineering machinery shown at the Exhibition, and important papers read at the congress, and the visits to the great steel and engineering works in the vicinity.

Of these one of the most interesting is the John Cockerill Establishment at Seraing. This great concern was started more than a century ago by the son of an English emigrant. In 1824 John Cockerill erected a coke-fired blast furnace, and in 1835 built the first locomotive anl rolled the first rails made on the Continent of Europe. The Cockerill works were the first to introduce the Bessemer steel process in Europe, and were pioneers with regard to the use of blast furnace gas and gas from coke ovens. They make gas engines up to 10,000 H. P. in capacity, and the Members of the Institution were shown two 8,000 H.P. gas engines in the Cockerill power house, one in course of erection and the other at work. M. Adolphe Greiner, the late chairman of the company, was the first foreigner ever elected as President of the British Iron and Steel Institute, and he was also awarded the Bessemer Gold Medal.

This firm suffered heavily in the War, five blast furnaces and nine rolling mills being destroyed and more than a thousand machine tools taken to Germany, but the work of reconstruction has been carried out with great rapidity, and pig was being poured and many of the departments of the company were in full production when the writer went through the works. The Cockerill Company took a very active part in mining and metallurgical matters in France, Spain and Russia. It constructed blast furnaces and steel-works in China for the Chinese Government, and in every direction has made itself a progressive factor in the metallurgical world.

Another Works visited by the Institution was the Ateliers de la Meuse, which, in addition to locomotives and mining machinery, constructs great quantities of steel works plant. Electrically driven turbo-blowers are made for blast furnaces, Thomas and Mar-

tin converters, mixers, ingot cranes, pumps, steam and electric ladle cranes, ladle wagons for carrying molten cast iron by rail, water jackets for the treatment of rare metals, electrically driven billet chargers for reheaters, two and three high rolls, trains of rolls for small sections, three high blooming mills, roller tables and transporters, reversible rolls, zinc rolling mills, sheet iron rolls, rolling mill engines up to 4,000 H. P. anl pillar hyrdaulic cranes for metallurgical work.

The Usines à Tubes de la Meuse have some interesting plant at their works at Flemalle-Haute. This consists of two rolling mill trains for weldless tubes. The one, of the continuous type, rolls hot all the rough tubing down to 90 mm. external diameter. These tubes are subsequently drawn down further cold or hot, according to the purpose for which they are required. The other rolling mill is of the "Pelerin process" type and is used for large weldless tubes from 90 to 216 mm. outside diameter and up to 10 to 12 meters in length.

The Angleur Steel Works has interests in ore and coal mines, and two large works near Liege. Of these the Renory Works has a Martin steel foundry, Stenay steel foundry, iron foundry, four openhearth steel furnaces, one rolling mill for sections and merchant bars, a tyre rolling mill, steam hammers and plant for the manufacture of wheels and axles. The Tilleur Works has four blast furnaces, four Bessemer basic steel converters, two mixers, a blooming mill, a large reversible rolling mill for rails, sleepers, sheet, and bars, a medium and small set of rolling mills, 84 coke ovens and a 15,000 H. P. electric power plant. There is also plant for producing Bessemer basic and openhearth Siemens-Martin basic steel; ingots slabs, blooms, billets, bars, and plates; flat bottom rails, tramway rails and light mining rails; fishplates, bearing plates, steel sleepers, axles anl tyres, wheels, rolled sections, steel and iron forgings, rolling mill rolls, points, crossings and the like. This latter Works is another example of Belgian industry, for it was completely destroyed by the Germans but is now in a position to produce an even larger output than before the War.

Behaviour of Metals at High Temperatures

Amongst the important papers read at the meetings of the Institution abroad was one by Professor F. C. Lea, O.B.E., D. Sc., on "The effect of temperatures on some of the properties of metals." Dr. Lea showed that the modern tendency is to subject metals to constantly increasing temperatures, in high pressure boilers and superheaters, in high pressure turbines using superheated steam, and especially in internal combustion engines. It thus becomes important to investigate the properties of metals, not only at normal temperatures, but also at the high temperatures which are met with today. It is not sufficient to know the effect of temperature on the breaking strength of metals, for in many cases metals are subjected to reppetition stresses at high temperatures, and thus it becomes important that the form of the stress-strain curves should be investigated, and sometimes, that the effect of temperature on the Modulus of Rigidity and the Modulus of Elasticity should be known.

In the case of the pistons of the internal combustion engine, the tensile strength of the material at the temperature of working need not necessarily be very high but it is important that the material of whatever kind, should retain sufficient hardness to prevent deformation under stress. The effect of temperature therefore on the brittleness, limit of proportionality, yield point (if certain metals have such a property) Modulus of Elasticity, and finally, on the range of repetition stress to which materials may be subjected, becomes important.

In the paper read by Professor Lea, experiments that have been carried out during the past ten years were described. The experiments have at times had special reference to particular engineering problems, while others were undertaken simply as an attempt to add to existing knowledge of the properties of metals, and in this connection attention has been paid to "critical points" which may throw some light on the rather extraordinary changes wheih take place in metals when subjected to particular temperature conditions. The critical points which occur in temperature curves show changes of particular properties with temperature, and are of great interest, as they are apparently related to important changes in the material, which take place at these particular temperatures.

For example, the maximum strength in tension of a mild steel bar at temperatures between 0 and 500 deg. C., occurs at temperature of 220 deg C., approximately and it is at this temperature that the minumum elongation per cent. occurs. Curves connecting the strength of heat treated steel wires with temperature show a critical point at about the same temperature, the point moving with the temperature as the carbon content is increased. The experiments have also shown critical points on the curve showing a change of torsional rigidity with temperature. Other workers have shown that there is a "critical point" at about 214 deg. C., in the curve connecting the changes in magnetic permeability with temperature, and that this point moves with the composition and history of the material.

Professor Lea describes the apparatus used in carrying out his experiments in the paper above-mentioned and from the results obtained and other work which has been done on the same subject he has been able to arrive at the following conclusions. Below 250 deg. C. the effect of temperature, particularly on steels, does not give cause for anxiety in their use, in cases where the above limit is not exceeded. Many of the alloys of copper on the other hand, and also those of aluminium, are considerably affected by temperatures of 250 deg. C., and it is unwise to assume, because an alloy is as strong as steel or iron at ordinary temperatures, that it will remain so at higher temperatures.

Temperatures above 350 deg. C., which may be reached in the case of aeroplane engine springs, may have a very marked effect on the elastic properties of steels. The Limits of Proportionality may become quite small, there are possibilities of hysteresis loops at comparatively small ranges of stress, and the Moduli of Rigidity and Elasticity may be considerably less than at ordinary temperatures.

We have received from the Dominion Bridge Company, Toronto Office, a copy of their current Stock List of Steel Shapes and other metal products available for immediate shipment. The booklet contains several pages of weights, safe loads for Beams, Channels, Angles, etc., and general information. The Company will be pleased to forward a copy on request to those interested.

The Constitution of Coal

ABSTRACT OF THE FIRST OF FIVE LECTURES DELIVERED AT SHEFFIELD UNIVERSITY, ENGLAND, BY DR. MARIE CARMICHAEL STOPES.

Common house or factory coal, generally known as ordinary bituminous coal, is banded or streaky, and appears to the naked eye to be black. In most geological text books coal is classed as a mineral. The old name used, indeed, to be "stone coal" but this is misleading, for coal is not a mineral at all, but a mummy.

What is coal? At a meeting of the Society of Chemical Industry in 1918, I had the temerity to define coal provisionally: "Ordinary coal is a compact, stratified mass of dismembered, mummified plants free from all other matter, save for the mineral veins, partings, etc., which are local impurities". To be coal the deposit must be substantially a deposit of plants alone. Impure coals may grade into oil shales and a variety of other products.

In mummifying animals and human beings the ancient Egyptians took out the softer viscera and replaced them with resins and preservative substances. Similarly, in coal the softer parts of the plants are naturally attacked first by the bacterial action and decay, and the "resins" accumulate, tending alone to be represented after the decay of portions of the soft tissues of the plant mass.

There is no foundation to the idea that there was a special form of flora in the "Coal Measure epochs" which gave rise to the accumulations forming coal. Any portion of any plant is capable of forming coal of a sort. There is nothing in the Coal Measure flora which makes it particularly coal-producing, for given equally favourable physiographical conditions leading to accumulating deposition, any other flora of any other geological epoch would make coal.

The Locus of Coal Deposits

In some form or another, either in large lagoons or lakes, estuaries or brackish marshes, the coal-forming material drifted and sank. One may classify the ways of accumulation as follows:—

In Sea Water

Drifted land material, which may travel far, settling water-logged beyond the reach of mineral detritus.

Fucoid Algae, forming shore accumulations.

In Brackish Water

In situ material, the dropping of coastal forests.

In situ, or partly *in situ* swamp and bog plants.

In Fresh Water

In undisturbed lakes, from forest debris, or pure plankton" or microscopic life of the lake, plants growing *in situ*, or all these mingled.

In estuaries, river bonds and deltas.

In large swamps interspersed with lakes.

On Land

Highland moors of various types, mosses, moorpeats.

Peat and forest, mingled or alternating.

Dry forest floor accumulations.

This fundamental fact, viz., that all vascular plants share the same chief types of tissue cells, is the explanation of the gross similarity between coals of very different geological ages—for Cretaceous or Tertiary coals may be substantially identical in their response to the ordinary chemical tests with coals of the Paleozoic age, though the species of plants forming the two coals are entirely different

The Analysis of Coal

The method of dealing with coal must be much more accurate and refined before the distinctive contributions of different plant species can be recognitions of the various tissue substances widely scattered in all plants, such as lignin, nuclein, cellulose, "resin," and so on.

The chemist who analyses coal in bulk for the great commercial enterprises which use coal by the hundred tons, has got into the way of presenting his analysis in a form which may be of value to the commercial man, but which does not indicate in the least the real chemical composition of the substances comprising such a mixture. Indeed I consider that the chemist's knowledge of coal at the present moment is that of the Dark Ages. It is misleading in a way exactly parallel to the confusion in analysis which would be created were a mixture of say, 20 different mineral compounds pounded all together, analyzed merely for the elements. Yet in their analysis of coal chemists present but a crude tabulation of percentage of the elements contained, not in any one compound but in this mixture of compounds!

The Constitution of Coal

Realizing this very clearly a few years ago, I set to work on certain differences in coal which appeared to me to be so obvious that in a block of coal, only a few inches big, the naked eye could detect four physically different bands or zones. These microscopically recognizable portion of coal are to be found in most ordinary bituminous coal, and I named them provisionally as follows:—

1. *Fusain*—The equivalent of "mother of coal", "mineral coal" etc.
2. *Durain*—The equivalent of "dull" hard coal.
3. *Clarain* and, 4. *Vitrain*—together the equivalent of "bright" or glance coal. Sometimes the "bright" coal of an author seems to be the vitrain only. Vitrain has a conchoidal fracture.

These names do not represent chemical entities (with the possible exception of vitrain), but they do represent tangible entities of the same useful order as "jet", "granite", or "cheese".

The generally "streaky" or banded nature of a seam of coal is of varying magnitude, and as one magnifies a banded piece of coal more and more it becomes increasingly apparent how finely laminated it may be. The average "dull" band is from 1/4 inch or more in thicksess, and is all through visibly streaked with fine lenticles of "bright", while the "bright" portions are streaked with very variable bands of "dull" and the "bright", both the fusain and the vitrain, are all essentially lenticular masses; these are often so horizontally extended and so thin that they create the impression of being fine horizontal bands. The fusain is the least regular in its arrangement, but on the whole its more wedge-shaped portions tend to lie so as to be most apparent on the surfaces which are split parallel to the bedding.

Vitrain is particularly interesting. These brilliant bands are more definitely distinguishable from the rest of the coal than are the bright clarain and the dull durain from each other. True vitrain generally forms a very definite and often sharply straight-cut band, varying from 2 mm. to 6 mm. or 8 mm. in thickness. There are also brillant streaks of smaller size, down to almost hair-like flecks. The larger, however, are more typical of the vitrain zones. They are notably less numerous than the zones of glossy bright clarain and are differentiated by the fact that clarain, under the

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This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

Accumulators, Hydraulic:
Smart-Turner Machine Co., Hamilton, Ont
The Dominion Steel Products Co., Ltd., Brantford, Can.

Air Compressors:
R. T. Gilman & Co., Montreal.

Aluminum:
A. C. Leslie Co., Ltd., Montreal.

Angle Bars:
Steel Company of Canaa, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Barbed Wire Galvanized:
Steel Company of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Anchor Bolts:
Steel Company of Canaa, Ltd., Hamilton, Ont.

Axles, Car:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N S
United States Steel Products Co., Montreal.

Axles, Locomotive:
Nova Scotia Steel & Coal Co. Limited, New Glasgow N.S
United States Steel Products Co., Montreal.

Barrel Stock (Black Steel Sheets):
Seneca Iron & Steel Co., Buffalo, N.Y.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bars:
Dominion Iron & Steel Coy., Ltd., Sydney, N S
United States Steel Products Co., Montreal.

Bars, Iron & Steel:
Manitoba Steel & Iron Company
Canadian Western Steel Co., Calgary, Alta.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S
Ferguson Steel & Iron Co., Buffalo, N.Y.
The Steel Company of Canada, Hamilton, Ont.
Beals, McCarthy & Rogers, Buffalo, N.Y.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S
Canadian Drawn Steel Co., Ltd., Hamilton, Ont.
Canadian Tube & Iron Co., Ltd., Montreal.
Leslie, A. C. & Co., Ltd., Montreal.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bars, Steel:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N S
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Billets, Blooms and Slates:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N S
Steel Company of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Belting, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Benzol:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Steel Company of Canada, Ltd., Hamilton, Ont.

Binders, Core:
Hyde & Sons, Montreal, Que.

Bins, Steel:
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto
Toronto Iron Works, Toronto, Ont.

Black Steel Sheets:
B. & S. H. Thompson & Co., Ltd.
Seneca Iron & Steel Co., Buffalo, N.Y.
Leslie & Co., Ltd., A. C., Montreal, P. Que.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Blooms & Billets:
Algoma Steel Corp., Ltd., Sault Ste. Marie.
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Boilers:
Sterling Engine Works, Winnipeg, Man.
R. T. Gilman & Co., Montreal.

Bolts:
Baines & Peckover, Toronto, Ont.
Steel Co. of Canada, Hamilton, Ont.
Canadian Tube & Iron Co., Montreal, P.Q.

Bolts, Railway:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N S
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bolts, Nuts, Rivets:
Canadian Tube & Iron Co., Ltd. Montreal
Steel Company of Canada, Ltd., Hamilton, Ont.

Box Annealed Steel Sheets:
B. & S. H. Thompson & Co., Ltd.
Seneca Iron & Steel Co., Buffalo, N Y
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Brass Goods:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Brick-insulating:
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.

Bridges:
Hamilton Bridge Works Co., Ltd., Hamilton.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.

Brushes, Foundry, Core:
Hyde & Sons, Montreal, Que.

Buildings, Metal:
Pedlar People, Limited, Oshawa, Ont.
Hamilton Bridge Works Co., Ltd., Hamilton.

Car Specialties:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.

Carriers:
Canadian Mathews Gravity Carrier Co., Toronto, Ont.

Gaskets, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont

Cast Iron Pipe:
National Iron Corporation, Ltd., Toronto
Hyde & Sons, Montreal, Que.
Canada Iron Foundries, Montreal.

Castings, Aluminum:
Wentworth Mfg. Co., Limited, Hamilton, Ont.

Castings, Brass:
Wentworth Mfg. Co., Limited, Hamilton, Ont
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Bronze:
Wentworth Mfg. Co., Limited, Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Gray Iron:
Canadian Steel Foundries, Ltd., Montreal P.Q
Electrical Fittings & Foundry, Ltd., Toronto, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Nickel Steel:
Hull Iron and Steel Foundries, Ltd., Hull, P.Q.
Canadian Steel Foundries, Ltd., Montreal P.Q.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
Dominion Steel Foundry Co., Hamilton, Ont.
Joliette Steel Co., Montreal, P.Q.

Castings, Gray Iron:
Reid & Brown Structural Steel & Iron Works, Ltd., Toro
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Castings, Malleable:
Canadian Steel Foundries, Ltd., Montreal P.Q.
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Castings, Steel:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Cement, High Temperature:
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.

Chrome:
American Refractories Co.

Chemists:
Toronto Testing Laboratory, Ltd., Toronto, Ont.
Milton Hersey Co., Ltd., Montreal.
Charles C. Kawin Co., Ltd., Toronto.

Chucks Lathe and Boring Mill:
The Dominion Steel Products Co., Ltd., Brantford, Can.

Clip and Staple Wire:
The Seneca Wire & Mfg. Co., Fostoria, Ohio, U.S.A.
United States Steel Products Co., Montreal.

Concrete Hardener and Waterproofer:
Beveridge Supply Company, Limited, Montreal

Consulting Engineers:
W. E. Moore & Co., Ltd., Pittsburg, Pa
W. S. Tyler Co., Cleveland

gloss, will always show streakiness, whereas vitrain will not.

As observed by the naked eye, *fusain* occurs chiefly as patches and wedges, somewhat flattened parallel to the bedding plane, and often with rather square-cut ends. It consists of readily detachable, somewhat fibrous, strands. The various wedges on a bedding plane lie at various angles to each other, so that in any given light some appear dull and some glisten.

Durain is hard, with close, firm texture, which appears granular even to the naked eye. A broken face is never truly smooth. It always has a finely lumpy or matted surface. Generally a few flecks or hair-like streaks of bright coal are to be seen.

Clarain occurs as bands of very variable thickness, which are ultimately widely extended lenticular masses. Even where streaked with durain, clarain has a defined and smooth surface when broken at right angles to the bedding plane. These faces have a pronounced gloss or shine. This lustre is inherently banded and shows bands of fine durain.

Vitrain occurs in definite narrow bands, sometimes straighter and flatter than the other bands of coal, and sometimes more obviously lenticular. The limiting layer between the vitrain and the contiguous clarain or durain is generally sharply marked. There is no fine interbanding detectable, but it is a uniform, brilliantly glossy, vitreous whole in its texture. The conchoidal fracture is characteristic.

Under the microscope *fusain* is almost black, opaque, and when it shows the cellular structure of the wood from which it was formed, it reveals the walls as much thickened and the cell lumina as being generally empty.

Sections of *durain* show a granular matrix of roundish or polyhedral fragments, the majority of which are blackish or opaque. The granules are closely packed and form a coherent mass, but mixed with them are the most characteristic spore exines. The ground mass of rather opaque granules, and the large, clear macrospore exines tend to preponderate. The small, clear, lenticular bands or flecks of a more golden colour seen in the durain are streaks of clarain. Other light coloured bodies to be seen in the durain are the supposed "resin" bodies.

Clarain is essentially clear. Plant tissues preserved in it are translucent. Opaque streaks of durain should be looked upon as an impurity. Clarain is the happy hunting ground of the paleontologist in search of preserved remains of the tissue composing coal.

Vitrain is essentially uniform, structureless, and may be compared to a hardened glue or jelly.

All four substances, fusain, durain, clarain and vitrain, show sufficient variation and characteristic differences of response to chemical tests to mark these substances as being distinct from each other. The coking qualities of each are markedly different.

* * *

Both the microscopic study of the petrography of rocks and the microscopic study of the internal structures of metals at their initiation seemed researches remote from practical use. Both, however, have abundantly justified themselves, not only in the scientific world but as aids to practical men of affairs.

Similarly I maintain that knowledge of the minute structures and the chemical properties of the individual substances composing that highly complicated mixture known as "coal" will be justified in its turn.

Indeed I am bold enough to maintain that until we attain to a recognition of its differing essential compounds (which is the chemical worker's investigation of coal), the chemistry of coal will remain in the Dark Ages.

CANADIAN METALLURGY AT EXPOSITION

Canadian metallurgy will be well represented at the Eighth National Exposition of Chemical Industries which will be held this year during the week of September 11-16th, at the Grand Central Palace, New York. The great raw material supplies of the Dominion, particularly in the matter of metallic ores and the water power as yet undeveloped and available for use in the industry, will be the subject for several of the leading Canadian exhibits at the Exposition. Among the exhibitors from Canada who have contracted for space at the 1922 Exposition thus far, are included the Department of Mines of the Province of Ontario, the Forest Product Laboratories and the Water Power Branch of the Department of the Interior of the Dominion. In the Canadian section of the Exposition, an entire section will be given over to the exhibit of Canadian products, — the British American Nickle Company will have a booth. The International Nickle Company will also display the products which they manufacture from the ore to the finished metals and derivatives. The Scientific Press of Canada will be represented by the Canadian Mining Journal, Iron and Steel of Canada, the Canadian Textile Journal, the Pulp and Paper Magazine of Canada, and Canadian Chemistry and Metallurgy will be there.

While the Canadian exhibitors will exploit the raw materials of the provinces and illustrate the opportunities for American capital in Canada, the chemical and chemical equipment industries of the United States will have on display practically all the products used by the consuming industries of the Dominion. Every conceivable type and grade of chemical product for mining and metallurgical operations will be shown by the manufacturers who will display their wares at the Exposition. As for chemical machinery, everything from the largest crushing mills to the most delicate of precision instruments will be shown. Special sections will be given over to various phases of industry. The Power Section with its combustion efficiency devices for fuel conservation and general combustion problems will be one of the largest at the Exposition. A section given over to fire fighting apparatus for chemical and other special uses will show the latest developments in this field. Photographic materials, especially the use of photomicroscopic work in the industries with particular reference to metallurgy and the broader use of microscopic work in the metal industries including iron and steel, have been given a special section in which the booth of the Technical Photographic and Microscopical Society, the members of which have done remarkable work in industrial photography, will be one of the leading attractions.

Other branches of industry which will have special group exhibits among the expected 450 firms participating will be the Container Section. All types of new developments in shipping containers, barrels, cases, cartons, and the like, will be displayed in conjunction with packaging, labeling, conveying and loading machinery. In the fire fighting section, apparatus for the prevention of dust explosions in mills, industrial plants, grain elevators, mines and factories, will also be shown. To date, some 400 exhibitors have contracted for space and arrangements are being made for 450. This figure compares with 83 exhibits at the original Chemical Exposition back in 1915 and with 427 in 1921.

Among the speakers who are scheduled thus far are Herbert Hoover, secretary of Commerce of the United States, on "Standardization and What It Can Do For the American Chemical Industry", and Wayne B. Wheeler, general counsel for the Anti-Saloon League on "The Attitude of the Anti-Saloon League Toward Industrial Alcohol." Others of interest to the mtal industries include "Standardization of Fire Clays and Refractories" by Ross C. Purdy, secretary of the American Ceramic Society and Chairman of the Committee on Refractories of the American Society for Testing Materials; "Standardized Testing Apparatus" by N. F. Harriman of the United States Bureau of Standards; and "What Has Been Accomplished in the Standarization of Scientific Apparatus" by J. M. Roberts, secretary of the Association of Scientific Apparatus Makers of the United States. The Moving Picture program includes a number of reels on metallurgical subjects, including "The Preparation of Nickle and Securing Copper as a By-Product" in four reels accompanied by a spoken discussion, courtesy of the International Nickle Co.; "Prospecting for Gold in Northern Ontario" and "Assaying for Gold in Northern Ontario" by courtesy of the Ontario Department of Mines. Other details of the program will be announced later.

EDITORIAL

THRIFTY CANADIANS

There is a belief current throughout Canada that we have now attained the state of nationhood. Canada's experience in the Great War is judged (in the main,correctly) to be to our country what the twenty-first birthday is to a young man. But like the young man, Canada has a long way to go, and a hard way at that, before we can pride ourselves on having attained the essential attributes of nationhood.

As with a young man, so with a young nation, earning power and financial solvency are the touch-stones of material well-being. In our case, no one will question Canada's ability to produce wealth beyond the average even of young countries; nor does our country's financial status alarm the well-informed, even though it may press hard upon those in authority upon whom devolves the duty of paying Canada's bills. It is the present wide-spread spendthrift habit of Canadians that is a matter of grave concern to those who take time to consider seriously the national well-being.

Nature has been so bountiful to us that the average Canadian earns a competence with comparative ease. True, we are a nation of workers, and our average production is high. But the Canadian does not have to struggle for a livelihood as does a German, a Frenchman or a Japanese. This is a fortunate circumstance that will stand us in good stead for generations to come, if we use the privilege rather than abuse it.

At present the average Canadian is inclined to waste the treasure that nature provides. It is a case of "easy come—easy go." We have still to learn the lesson that has taught every peasant in France the value of a bank-account, and that made Britain the world's creditor. Only the merest fraction of Canadians have yet learned to save and to invest. Until the lesson of thrift has been well ground into us, we will continue to be on a par with the reckless youth whose new-found freedom from parental authority results in an orgy of expenditure—with its inevitable results.

Canada is fortunate in having at present a Minister of Finance who is fully aware of our besetting sin (in the financial way), and who is determined to exert every means within his power to help his countrymen to overcome it. Mr. Fielding's announcement that the Victory Bonds issued in 1917, which mature December 1st of this year, can be converted on favourable terms into another issue of Dominion bonds, is an inducement to a host of small investors to carry on the good habit they inaugurated five years ago. The elimination of the tax-free concession will make the new loan less attractive to large investors, and that is not to be regretted.

We hope, and believe, that the growing spirit of nationalism will be sufficient at this time to induce a general response to the test now provided by our veteran Minister of Finance. We must learn to be thrifty, for our own sakes as well as for the sake of our country.

SCARCITY OF FLUORSPAR PREDICTED

The United States Bureau of Mines has recently conducted an examination of the fluorspar deposits of Southern Illinois and Western Kentucky, whence is derived the larger part of this continent's supply. Mr. R. B. Ladoo, the officer of the Bureau who made the examination, concludes that, unless new deposits of fluorspar are found, there will be a decided shortage of the mineral within a few years, known reserves now being of small dimensions.

When the steel industry was booming, Canadian fluorspar, from the Madoc district, Ontario, found a ready market. Since the boom broke Canadian fluorspar has not been able to compete with the imported mineral. Mr. Ladoo's conclusion is of decided interest to Canadian fluorspar operators, as well as to iron and steel men.

HIGH PRICES OF COAL TO REMAIN

It now seems to be assured that all Canada's domestic resources of coal will be available during the coming winter. The 7,000 miners of Alberta and eastern British Columbia have voted by an overwhelming majority to accept the recent offer of the operators. The 12,000 miners of Nova Scotia have approved by a large majority the compromise effected by their leaders with the British Empire Steel Corporation, and are back at work. Meantime the coal mines at Vancouver Island and New Brunswick's one pit are being worked to capacity.

Throughout this period of acute disagreement over wages, it has been obvious that both the operators and the miners of Alberta have been closely allied with the respective organizations across the border. Hence it was a foregone conclusion that when industrial peace was foreshadowed and finally declared in the bituminous coal fields of the United States a similar settlement would be made in Western Canada. In District No. 18, U.M.W.A., as in the United States the compromise effected is mainly in favour of the miners. The time for the reduction in the wages of coal miners, which will assuredly come eventually

as must a reduction in the wages of all labour still unduly enhanced, has been postponed indefinitely.

In Nova Scotia the case has been somewhat different. Special conditions, including the old-time agreement of partial non-interference by U.M.W.A. headquarters in local Nova Scotian affairs, postponed the final "show down". The representatives of the British Empire Steel Corporation made offers to the miners from time to time, which we believe to be as high as the conditions at those various times warranted. When the awards of the two recent arbitration boards were made, there seemed a distinct likelihood of the reduction in the cost of producing coal in the United States, with a consequent all-round reduction in selling price. Since then those hopes have gone glimmering. It is now certain that the wages of miners in the United States will remain at or near the war-time peak for some time to come. There is no doubt that this fact led the British Empire Steel Corporation to make their attractive, though belated, offer to the miners on August 13th and likewise made it possible for them to agree to the similar terms that are now before their miners. The special concession to the miners is the long-term agreement that has been effected. As it is beyond question that the company intend to live up to this agreement, we may take it to mean that in the judgment of these operators, coal prices on this continent are destined to remain at their present high level for an indefinite period.

The terms of settlement of these strikes can afford us comfort for the immediate future; we shall not go without fires or railroad service during the coming winter. But what of the more distant future? Coal is the basis of the world's industrial system, as well as the main source of our artificial light and heat. With this point in mind, British industrial leaders fought to a finish the demands of British miners for what has been determined as more than their fair share of the nation's income. The miners of Britain are now working hard for a living, as are all their fellow-citizens. The British nation judged their case and refused their demands. On this side of the water the issue has not been so clear-cut, and the decision now arrived at savours of temporising. Neither miners nor operators have been fighting on behalf of the public, and the public has not been sufficiently interested to exert its undoubted right to decide the question. Consequently the active disputants, finding that the third party to the dispute is, to all intents and purposes, blind to the issue, have agreed to close the argument, and to make the third party pay. Thus the net result of all this hubbub is that the miners will continue to receive wages out of proportion to the service they render the community, the operators will pass on the bill for this to the public, coal will remain at a high price, and the much-desired deflation in the cost of living will be prevented for we know not how long.

If we need any corroboration of the soundness of these deductions, we need only refer to the recent action of the United States Steel Corporation in increasing the wages of their employees. These wages had been reduced toward the low level it was desired to attain throughout industry. Now this low level seems impossible of attainment, and the Steel Corporation, in mere justice to their employees, have raised their wages once more.

So, as usual, the average citizen will have to foot the bill. Those whose remuneration is now at or near the pre-war level will feel this most. When a sufficient proportion of these average citizens realize clearly that the wages paid to specially privileged classes of labour are paid by themselves, then, and only then, will equality be achieved and justice meted out.

A HUNDRED YEARS AGO

To understand the present and see as far as may be into the future, one must study the past.

It is nearly a hundred years since there was written the two-volume account of *Five Years Residence in The Canadas*, by Edward Allen Talbot, Esq. of the Talbot Settlement, Upper Canada. Among his shrewd observations is the following account of Canada's first attempt at a domestic production of iron and iron manufactures:

"Iron Ore is exceedingly plentiful in various Districts: It is of the kind called 'Shot-ore' [bog ore?]. In Upper Canada, however, there are only two Iron or Metal Foundries,—one in the neighbourhood of Long Point, on the shores of Lake Erie,—and the other in the township of Marmora, Midland District. The former, which is now in extensive operation, has been established by a small company of Americans from the State of New York; the latter belongs to Mr. Charles Hayes, of the house of W. and R. Hayes, in Bridge-street, Dubblin. How far these gentlemen may succeed in money-making, remains yet to be proved! If the difficulty of procuring labour were not so great, and the price of it not so high, I should entertain no doubt of their ultimate success. But in a country, where the commonest labourer will not work at a manufactory of this nature for less than £40 per annum, beside his board and lodging, the prospect of emolument to the adventurer is very dubious. One thing, however, is certain; if any kind of manufactory succeeds in Canada, it must be this. Potash-kettles, stoves, sugar-boilers, and, in fact, every article of wrought or cast iron, are in great request. The only question that remains to be answered, is, 'Cannot the merchants who import these articles from Europe, afford them at as low a rate as those who manufacture them in Canada?' To throw some light upon this subject, I shall just mention the prices of such articles at Niagara, which is nearly 200 miles higher up the country than here. Hayes's Foundry cast metal of every description sells by retail at four pence per pound:—English bar iron, at twenty shillings per hundred weight:—And steel, at six pence per pound."

Fancy! Wages at less than $200 a year with board and lodging, castings selling at eight cents a pound, retail bar iron at $4.50 a hundred and steel twelve cents a pound! Those were the conditions in Canada a hundred years ago when these adventurous pioneers began to

found a Canadian iron industry. This was not quite the first attempt. In 1800 or thereabouts a small iron furnace was built at Furnace Falls, now Lyndhurst, on the Gananoque River, and an attempt was made to use a small hematite deposit which had to be drawn a long distance. From the fact that the attempt to cast pots and kettles from the pig iron was a complete failure, it is not surprising that this enterprise was abandoned after a two years' trial.

About 1813 came the second attempt by John Mason, an Englishman ,who built a furnace to use the bog ore of Norfolk County, Lake Erie. But his furnace went to pieces after a few tons of pig had been produced, and another failure was recorded. Whether due to this or not, the unfortunate Mason did not survive the death of his business. In 1820 Joseph Van Norman with two associates bought and re-built the furnace, which was blown in in 1822, and thus began the first successful Canadian iron industry. It lasted until 1847, when it was closed owing to scarcity of ore and fuel. The furnace produced 700 to 800 tons of pig iron a year, running only 8 or 9 months. As there was no market for pig iron, it was cast into pots, kettles, stoves, and other castings needed by the settlers. The huge potash kettles used in making potash from wood ashes may still be seen in some Ontario farm yards.

It is likely that Van Norman and his partners were "the small company of Americans from the State of New York", alluded to by Talbot. Van Norman "succeeded in money-making", but his contemporary Hayes or Marmora was not so successful. He deserved to succeed, if resourcefulness could have carried him through. It is told of him tahat once when the supply of charcoal gave out he kept his furnace going with wood and actually produced pig iron! The cause of failure was difficulties of transportation, — a thirty-two mile haul to Belleville over unpeakable roads. These were very different conditions from those under which Van Norman carried on his business on the shore of Lake Erie, as Van Norman himself found to his cost when in 1847 he took over the Marmora works and lost all he had made in the Lake Erie business. All of this points to the conclusion that has now become axiomatic. Even in these days of railways our iron masters place great dependence upon the aid of our navigable waterways.

FERRO-SILICON FROM FELDSPAR

For half a century past, researchers have been attempting to find an economically feasible method of making the potash of feldspar available for human use. All the multitude of processes tried out up to the present have failed of commercial success. Nevertheless, the reward of a successful issue would be so great that attempts are still under way, and eventually a process capable of successful operation is certain to be evolved.

Most of the processes tried out are foredoomed to failure because they aim at the recovery and use only of the potash in the mineral—at best 13 or 14 per cent. of its bulk. It can be safely postulated that the successful process must provide for the use of at least the major part of the feldspar. A commercially pure potash feldspar will contain, let us say, 65 per cent. silica, 18 per cent. alumina and 13 per cent. potash, the remainder being mainly soda. If we are to make use of the major part of the 'spar we must use this silica.

A short time before he died, in 1920, J. E. Johnson, Jr., the eminent American iron metallurgist, applied for patents that described the manufacture in the electric furnace of ferro-silicon from potash feldspar and scrap iron, the potash to be volatilized by the extreme temperature of the furnace, and the fume caught and condensed. Now we hear of a similar, but simpler, process, said to be in actual operation in Sweden. Ferro-silicon is made from the same ingredients, but the potash is not volatilized and remains in the slag in combination with the alumina and other slag-making ingredients of the charge. This slag, from which the potash is readily dissolved, is ground and applied directly to the fields as fertilizer.

If a process such as this is actually feasible, it presents an excellent opportunity to Canadian manufacturers of ferro-silicon. There are very large bodies of potash feldspar readily accessible along navigable water routes as well as along existing railways. As electricity is already the source of power used, no radical change in the present method of manufacture would be necessary.

The reputed successful operation of this process in Sweden may point the way to one more Canadian industry, well founded on our mineral resources and our cheap hydro-electric power.

EDITORIAL NOTES

A new process for the production of iron and steel, which has not yet received from Canadians the attention it deserves, is that now in operation at Grenoble, France, referred to before in these columns. The oxide or sulphide of iron is dissolved to form ferrous chloride, from which solution the iron is plated out, in its purest form, on a rotating mandrel by means of the electric current. At present the principal product is boiler tubes, for which the highly ductile iron is eminently suited. The metal is 99.97 per cent iron. By means of using an *electrolytic*, instead of an *electrothermic* process, the energy of the electric current is almost completely made useful, in contrast to the electric furnace, where a large fraction of the energy is dissipated as sensible heat. This process would seem to be eminently suited to Canadian conditions.

TENDERFEET

Twilight was dying into dusk. The moon,
New-risen, gave promise of rich radiance soon
To silver stream and forest and high hills,
Where barren boulders posed as sentinels.
The loon, unseen, poured out his harsh refrain,—
Harsh, yet harmonious in its dying strain.
A mystic glamour brooded o'er the scene;
All was precisely as it should have been,
Pipes lit, meal done, and flies not too malicious—
But no one volunteered to wash the dishes!

ANON.

Why The Refractory Is A Factor In Furnace Life and Capacity

By I. S. PIETERS, Engineering Dept., Jointless Fire Brick Co.

In the modern boiler room the furnace imposes the limitation. How soon the limitation is encountered depends upon how carefully the furnace is designed and the wisdom used in the choice of materials comprising it. It is only comparatively recently that the importance of the furnace has been fully appreciated.

It is the furnace that determines the maximum combustion efficiency that can be attained; it decides the economical efficiency that should be maintained. It is the furnace that is usually the first to wear out and so compel a shut down for repairs. It is also the factor that ordinarily determines how "hard" a boiler or a fire can be worked. The more closely boiler room operation is examined the more apparent will it be that the furnace is all-important. A study of conditions shows immediately why this is the case. Further, it explains why of recent years the furnace has come in for the largest amount of attention and the most radical changes.

Perhaps the most prominent tendency during the last few years has been that of operating boilers at higher rates of evaporation. One boiler horsepower is nominally equivalent to 10 sq. ft. of boiler heating surface; when every 10 sq. ft. of heating surface evaporates 34.5 lbs. of water per hour, the output is said to be one boiler horsepower. Actually, however, three to five times this amount of water may be evaporated for every square foot of heating surface. This means that somewhat more than three to five times the amount of coal must be burned in the furnace to evaporate this larger amount of water. By working existing equipment many times harder than the nominal, a given investment is made more useful or the money sunk in new apparatus may be reduced. It pays to work apparatus "hard."

Higher combustion rates necessitates radical changes both in the design of the furnace and the materials that go to make it. Larger furnace volumes are required so that the larger quantity of air and gas may mix with that intimacy so necessary for complete combustion. As ignition is largely a matter of time as well as temperature it has been necessary to increase the length of flame travel as well as the space available for mixing the air and combustible gases. To accomplish this, the height as well as the volume of the furnace has had to be increased.

Because of the larger quantities of coal going into the furnace at these high evaporation rates, the fuel beds are thicker and so offer higher resistance to the flow of air. Higher drafts thus become necessary as well as much larger volumes of air. Mechanical draft is resorted to, therefore, to handle the air and mechanical stokers are used to handle the fuel.

In consequence of these developments the furnace problems that have come about are twofold. They are those due to higher temperatures on the one hand and those due to mechanical considerations—greater height and greater volume—on the other, and they are closely interrelated. Before discussing the problem on account of the higher temperatures and larger furnaces or attempting to explain why they occur or how they may be mitigated and even eliminated altogether for long periods, a thorough understanding of what the furnace walls and interior must accomplish is worth while.

Conditions the Furnace Must Meet

The structure that constitutes the furnace must not only have sufficient strength to support itself at all temperatures that may occur, but it must be capable of supporting whatever loads may be applied to it and whatever stresses may be exerted over the range of temperature that occurs under the most extreme conditions.

Part of the furnace, the inside, must be capable of withstanding for a reasonable length of time the highest temperatures produced in the furnace—namely temperatures between 2,800 and 3,000 deg. F. It must also be capable of standing up under the erosion and attrition of coal, ash and clinker passing along it and adhering to it as well as attack by the fireman's slice bar while he endeavors to break off lumps of clinker and molten ash. The furnace lining must not be chemically reactive with the ash and clinker or impurities in the coal (which usually have low fluxing temperatures) otherwise the lining will surely flux and melt. It should have a minimum coefficient of expansion and contraction. The material must not be brittle or it will crack on rapid heating; but it must be tough so as not to be susceptible to abuse. It should not be too porous otherwise it will allow air to flow from the outside into the furnace; this cool air, of course, lowers the furnace temperature, wastes heat and fuel, may cause damage to the intensely hot boiler heating surfaces, may overtax an already overloaded stack and hasten the spawling of the refractory in the furnace. The flow of heat from the inside to the outside should be a minimum.

Each of these requirements — refractoriness, physical strength, surface hardness, low expansion and contraction coefficient over a wide temperature range, low heat conductivity, imperviousness to air — is of vital importance. These characteristics and requirements differ so widely that no one material can meet them all. Therefore, furnace walls and settings are no longer made up of one material as was once the case but three, four or more materials are used. Each serves an entirely different and distinct purpose; and in this way each material can be chosen specifically for the special condition it must meet.

This, in brief, explains why the furnace of brick or even of two different kinds is rapidly disappearing. It is the reason why the modern furnace with the longest life, lowest upkeep cost and highest thermal efficiency working under the extremely severe conditions of today is now invariably composed of three and sometimes four and five different materials.

Typical Furnace Difficulties

Most furnace troubles originate inside the furnace and these, in turn, contribute to, if they do not actually cause those that take place on the outside. Usually the trouble starts at the joints between bricks. Every joint is a weakness and every layer of cement or mortar a possible source of trouble. It is very easy to understand why.

Each brick expands and contracts individually according to its individual characteristics and the temperature to which it is subjected. Bricks differ quite widely among themselves in shape, size and ability to stand up under high temperatures; some shrink more than others and some never reach normal size again after heating. Bricks that are not true to size and shape exert a side thrust

against adjacent bricks. Bricks that are too hard are often brittle and crack with sudden temperature changes, on account of internal pressure due to unequal heating or external pressures.

Consequently, the interior surface of the furnace lining when of brick may be smooth and have all bricks flush when first placed into service but it soon assumes a rough and ragged surface to the fire as the individual bricks work about and some retire and others tend to protrude into the furnace chamber. Those bricks that are most exposed to the intense heat are the first to melt at the corners and edges. As they wear down, other bricks gradually protrude and these too melt so that an endless cycle of deterioration goes on.

The cement used to hold the bricks together is a source of trouble in the majority of furnaces using brick. It is an important factor in determining the strength of a wall as well as the thermal efficiency of the furnace and its life.

The layer of cement must necessarily be very thin—the thinner the better. On cooling after being heated, it usually shrinks and hardens. This weakens the joint, of course, and leaves voids where the cement was originally. As the bricks move on expanding and contracting, more cement is forced out from between the joints while some of it melts so that the bricks settle down and many of them become loose while others jam. One commonly finds bricks that can be lifted right out of the wall. It can readily be seen why the brick-work under these conditions is short-lived when the fireman roughly tries to dislodge adhering clinker from loose and crumbling brickwork. As the bricks disintegrate and the joints between bricks loosen up, more and more air tends to enter the furnace from the outside and the greater becomes the waste of heat from excess air.

Troubles with brick furnaces can be reduced, of course, by using only brick that is true to size and shape and that runs uniformly as to material. Further, the cement must be chosen so that it does not act as a flux for the brick and that it has as close as possible the same coefficient of expansion and contraction as the bricks it is to hold together. The great difficulty with brick, however, is that bricks in one consignment will vary among themselves. It is difficult to keep sizes uniform; the clay used may come from different locations; the heat treatment may differ so that some of the bricks are more porous, more brittle or of lower strength than others. Bricks in the same consignment may have been collected from different batches that have passed through different ovens so that while nominally the same brick they may have quite different characteristics. There are many opportunities for differences to creep in, and every difference in treatment and manufacture means a possible source of trouble.

At best brickwork is patchwork where not only the brick but the cement that binds them and the men that lay them are variable factors. The periodic heating and cooling to which the bricks are snbjected in service soon show the results. As a furnace may require from several hundred to many thousand bricks it is obvious that the opportunity for trouble is very great.

Troubles, frequent repairs, comparatively short life and high upkeep cost are inherent to the brick setting and the only scientific way to overcome them is to employ a one-piece or monolithic furnace lining.

How to Solve the Furnace Problem

Since experience as well as theory show that the joints are the weakest parts of the entire brick lining and also the chief cause of trouble, it can immediately be seen that if the joints can be eliminated an immense advance has been made toward doing away with furnace troubles. The elimination of joints almost entirely is probably the most radical step toward longer furnace life and the extension of furnace limitations that has taken place in a long time. This explains why the one-pice, monolithic or jointless lining is proving such a success, and why it is being used especially where furnace conditions are severe, where shut downs for replacements must be minimized and where high upkeep costs have become so serious as to compel that combative measures be adopted.

With the monolithic lining there are no joints. There are no bricks. The lining is a one-piece lining of the same material that after the first heat assumes a smooth, tough surface. There are no protuding parts to be exposed to the heat, to form the nucleus for the building up of clinker masses or to melt down and cause trouble and expense. There are no joints to cause weakness, to serve as channels for cold air to enter the furnace; no bricks to loosen and fall out; no cement to fuse and disappear and no unequal expansion and contraction.

The one-piece, jointless lining is monolithic, of homogeneous material with one coefficient of expansion. Expansion and contraction occur en masse, without unequal strains and without cracks. There is no chemical action between different substances; it all behaves alike for it is all of the same substance. The lining material is chosen for its ability to withstand heat and furnace conditions. It is a refractory used as a refractory where the requirements are for a refractory, so that all the troubles that do occur with the brick are absent.

When a one-piece or jointless furnace lining is used, the rest of the furnace may be built up of materials that insulate, that is keep the heat in the furnace, and have the strength to carry whatever load may be applied. Usually the insulating material is placed next to the refractory or heat-resisting material, and then is the outside brick used for its strength as a support and protection for the insulation and refractory. Quite often the outer brick is covered with an impervious paint to exclude air from seeping through the brick. As the jointless furnace lining seals up the whole inside of the furnace, the entry of air through it is further prevented, the increase in combustion efficiency due to this type of lining usually results in an increase of from 1 to 3 per cent in carbon dioxide.

The jointless furnace lining by doing away with all the inherent defects of the brick setting has increased the life of the furnace anywhere up to 500 per cent, reducing the cost of upkeep proportionally. It has enabled boilers to operate for more than a year and sometimes for two years without a shut down for furnace repairs where with brick, a new lining was required several times a year. It has increased combustion efficiency and so lowered the cost of fuel. It has enabled boiler evaporation to be increased economically far beyond the range formerly possible with economy.

In short, the elimination of joints in the furnace by adopting a highly refractory one-piece lining without any joints, has permitted big economies to be brought about and at the same time has extended the limitations of the furnace enormously.

E. W. Rossiter has been appointed Engineer of Construction for Freyn, Brassert and Company. Mr. Rossiter was previously Chief Engineer, Interstate Iron and Steel Company, Calumet River, Chicago, and, prior to that, with the American Sheet and Tin Plate Company, the Minnesota Steel Company, and the Canadian Steel Corporation, Limited, at Ojibway, Ontario.

The Geology Of Ontario's Iron Ores

DISCUSSION AT CONFERENCE ON IRON ORE IN TORONTO

By C. W. KNIGHT and W. H. COLLINS

At the conference on Ontario's iron ore problem, convened on July 5th last in Toronto by Hon. Harry Mills, Minister of Mines, the geology of the Province's iron ore deposits was discussed briefly, first by Mr. C. W. Knight, Assistant Provincial Geologist, and then by Dr. W. H. Collins, Director of the Geological Survey, Ottawa. Their remarks follow:

Mr. Knight's Address

This is rather a large question. I understood from Mr. Gibson he wanted me to say something about the geology of the iron ores in our Province, but this would be like bringing coals to Newcastle. In Ontario we have what is known as the Keewatin series. Unfortunately, the Keewatin series in the United States has not been attractive. The Animike is the main series in the United States, and in it is found the great Mesabi range which has produced about 73 per cent. of the ore of that country. This series in this Province is only two hundred feet thick, and strikes from Loon Lake to the American boundary. In the United States this series is from seven hundred to one thousand feet thick.

Just a word as to the character of the Keewatin ores and the Animike ores. The Keewatin ores are very much altered. They are practically all magnetite, but some are hematite, and they are found largely standing in vertical positions. The Animike rocks are flat lying. It has often been asked why it is that we have so many ores in Ontario which have not been concentrated, while across the line we have these valuable ranges. I think the two men who know more about this than anyone have probably given some of the best reasons. They think the glaciers must have scooped away these ores except in certain spots, the Helen Mine being an instance of the places that escaped the glaciers. That seems to be one of the main reasons why we have not got these ores. Another reason probably is that the structure of the iron formation in this Province has not been the same as in the United States, and also the rich character of the ores themselves is different. The richer ores are found by exploration under the drift and also through the rock, and in this regard our iron formations have not been properly prospected.

Dr. Collins' Address

It seems to me that the question of an adequate iron ore supply for the upkeep of Ontario's iron and steel industry should be considered under two heads:—ores that may be considered as primary, that is, ores that were formed in their present state at the time they were laid down; and the concentrated and enriched ores that have formed from these primary ores at some later time. It is to this second class that attention should particularly be directed by the prospector if a supply of ore is to be obtained without resorting to beneficiation. I am perfectly in accord with what Mr. Knight has said about the desirability of further prospecting certain of our primary iron formations for secondary enrichments.

We may group all our known iron ores into six types. The oldest, the Keewatin, is very widespread. We find it all over Northern Ontario, from the extreme west to the east, and as far south as Georgian Bay. This Keewatin iron formation might again be divided into two types, the banded silica and magnetite type, and the second one, really very closely related to it, the carbonate type, which is particularly characteristic of the Michipicoten District. The banded silica and magnetite type is of widespread occurrence. One finds a fairly good inventory of these deposits in the publication known as "Iron Ores of Canada" issued by the Mines Branch of the Federal Department of Mines. It is perhaps sufficient here to say that a good many of these deposits are so extensive that you can conservatively estimate their available contents in tens or hundreds of millions of tons. The only trouble is that they seldom run over thirty-five per cent in iron content and the silica content is too large for satisfactory blast furnace treatment.

Carbonate Ranges Insufficiently Explored

Carbonate formations are more promising sources for secondary concentrations. They consist on one side of banded silica and either carbonate or some form of iron oxide, and on the other side of a carbonate which is really a mixture of iron, lime, magnesia and manganese, scattered through which is a small percentage of pyrite and pyrrhotite. The pyrite, in the presence of oxygen and moisture, forms sulphuric acid. The acid drives off the carbon di-oxide and transforms the carbonate into iron sulphate. This sulphate when carried below ground water level reduces to oxide and becomes thus converted into hematite. The Helen iron ore is a sample of this secondary type of concentration, as are also the Josephine and the Frances. Now I might say that these carbonate formation ranges extend for many miles in the Michipicoten district, and also east of Lake Nipigon. Only a very small percentage, perhaps not more than ten per cent. of the linear extent of these ranges has been adequately prospected for secondary concentrations of the Helen type, which is an excellent ore, running about 55 per cent. iron. The primary carbonate, or siderite, was itself mined at the Magpie mine and roasted to drive off the carbon di-oxide and sulphur. The roasted product constituted an excellent ore carrying about fifty per cent iron, no moisture and lime magnesia and silica in proportions that required very little additional fluxing materials.

There is a third type of iron ore deposit, in one of which Mr. Leitch is interested. Iron formation of this type occurs east of Lake Nipigon, and in the Lake Savant district in the northwest corner of Thunder Bay district. This type of deposit consists of a greywacke or hardened mud interbedded with layers of iron ore, in the form of hematite and magnetite. Iron formations of this type do not ordinarily contain more than forty per cent. of iron, and they are highly siliceous and do not furnish in the natural state an ore suited for smelting. In their present state the iron oxides are not in suitable mineralogical form for natural concentration. If natural concentration has taken place, it was a long time ago, and the search for concentrations is going to be a difficult matter that will require all our available resources for examination.

Iron Ore in Animike Formation

The next type is the Animike formation, which in the United States has produced the great Mesabi deposits. We have this Mesabi type of iron formation, although

thinly, in two places. One of these has just been mentioned by Mr. Knight, in the Port Arthur district. Another one not belonging to Ontario is in the Belcher Islands, Hudson Bay. If, however, the Belcher Islands iron deposits are ever developed, it is quite possible that Ontario will benefit. These Belcher Islands deposits were examined last summer by a Government survey party, and they have been examined several times before, in the interests of Sir William Mackenzie and others. The results of last year's examination, which was confined to the eastern part of the Islands, indicate that there are 158 square miles underlain by the iron formation. The formation has a linear outcrop of 110 miles, and the ore itself ranges from a content of metallic iron of 52 per cent. down to about 35 per cent. Some of the analyses may be of interest to the meeting. The first one is from a bed two feet thick only, largely of magnetite, the metallic content of which is from 52 to 40 per cent, virtually no lime, magnesia or manganese, sulphur 0.1 and phosphorous 0.09. Unfortunately silica is about 24 per cent. The second bed, immediately underlying, and 11 feet thick, contains 45 per cent. of metallic iron, but 32½ per cent. of silica. The third bed, 12 feet thick, carries 39 per cent. of metallic iron, and 28½ per cent. of silica. The fourth band, fifteen feet thick, contains 35½ per cent. of iron and 46½ of silica. These ores are magnetite and the silica is interbanded in such a way that mechanical separation would be rather difficult. These are believed to be largely primary ores. The original ores were iron silicate and not very suitable for natural concentration and there is not much evidence that concentration has taken place. These ores are, however, of enormous extent, and there is a possibility of there being concentrations, although how these concentrations are to be located is no easy problem. The formations lie flat.

Minor Occurrences

A fourth type of iron ore deposit is that which occurs interbedded in the Lorrain quartzite and Gowganda formations along the north shore of Lake Huron. These are comparatively small deposits of hematite not capable of yielding any important tonnages of ore.

The fifth type is likewise of little commercial importance, so far as yet known. It comprises hematite deposits, both specular and massive varieties, which was apparently deposited along with the first sand and gravel of the St. Mary's sandstone which occurs near Sault Ste. Marie, and along the north shore and islands of Lake Huron. In some cases the iron oxide is a part of the St. Mary's sandstone and too impure to be an ore. In a few cases it appears to have accumulated in a purer state in crevices in the underlying floor of Huronian formations. The old Stobie mine near Gordon Lake is an example of these fissure fillings from which ore was formerly mined.

The iron ore deposits of eastern Ontario include various deposits of high iron content but, generally speaking, of small dimensions. These deposits, however, are too complex, geologically, to be described with any degree of success in the short time at my present disposal.

A LITTLE TALK ON THRIFT

By S. W. STRAUS, President American Society for Thrift

We are learning more and more that co-operation is one of the chief elements of business success. It is the oil that keeps the great, complicated machinery running smoothly. Too many men have made the mistake of believing that they could rise to success only through pulling down those ahead of them. But in the long run, such a policy of selfishness and discord never pays.

The elimination of this factor in a business organization is as necessary to efficient management and progress as the elimination of waste. In fact discord is waste, and co-operation is a fine type of business thrift.

The individual employee or member of the business organization should bear in mind that his own success must always be in proportion to the success of the institution to which his services are given. Thus as he co-operates with his co-workers to the common good he is benefitting his own fortunes and is in turn receiving the reciprocal benefits from his associates' endeavors. We help ourselves most when we help each other.

There is a rightful place in organized business for fair rivalry and competition among those who compose the personnel of any institution. There must always be the spark of initiative, and the incentives that lead to personal aggressiveness. Nothing is more deadly to business progress than a treadmill existence on the part of those who do the work, whether it be mental or physical.

The individual who wants to be thrifty of time and opportunity and get on in his work most rapidly will find that his progress will be constantly impeded unless he is imbued with the honest spirit of co-operation. Working with others in mutual accord is one of the chief qualities of efficiency. Time and energies otherwise employed represent waste.

It is a part of individual thrift to cultivate accord and to practise co-operation with those with whom we are associated in our daily duties. It is business thrift upon the part of executives to display these same qualities with their associates and to encourage them among their subordinates.

NEW STEEL FOUNDRY

Announcement has been made of the inauguration of a new steel foundry in Sherbrooke, Que. "Manganese and Steel Foundry, Limited," have taken over the premises on Water Street formerly occupied by the Sherbrooke Iron Works, and have already begun to execute a number of orders for their products.

The new company has at present a furnace of one ton capacity, capable of running three heats in a day. It is expected that the present equipment and capacity will be largely increased in the near future.

The president and general manager of the new company is Mr. P. McCullough, formerly of the Canadian Brakeshoe Company. Mr. A. S. Bayles, formerly of the Canadian Ingersoll-Rand Company, is secretary-treasurer.

OXYGEN PRODUCERS CONSOLIDATE

The consolidation recently of the manufacturing and distributing resources of the Dominion Oxygen Company, Limited, and the National Electro Products, Limited, gives to Canada one of the largest organizations of its kind on the continent. The business is henceforth to be conducted under the name of the Dominion Oxygen Company, Limited, now operating oxygen plants at Montreal and Toronto, and acetylene plants at Merritton, Winnipeg and Shawinigan Falls. In addition the company conducts oxygen and acetylene distributing stations at Hamilton, Windsor and Quebec.

It is claimed that the union of the two companies will be of material advantage to all Canadian oxygen users through stabilization of the product, assurance of steady supply and certain improvements in service facilities will make possible.

It is understood that Mr. W. J. Cluff and associates, of Toronto and Montreal, who founded the National Electro Products, Limited, several years ago, will retain their relationship with the oxygen industry through their interest in the consolidated companies.

The Development of Hadfields, Ltd., at Sheffield, England

WITH A DESCRIPTION OF THEIR NEW
11", 14" and 28" ROLLING MILL PLANT

The great new branch of the steel industry devoted to the manufacture of special steels has grown up mainly since the dawn of the 20th century, but with beginnings going back to the latter part of the 19th.

The development of modern alloy steels may be justly said to have originated with the discovery of Manganese Steel by Sir Robert Hadfield in 1882. This invention opened up a new era in metallurgical research, the results of which have brought high-class steels into general use, and revolutionised certain branches of engineering. The importance of the Hadfield inventions in helping to bring this about has been testified by the leading metallurgists in all countries and by the many awards and honours conferred upon him.

The applications of Manganese Steel to track work, dredger work and other engineering problems are now well-known. It may be mentioned that a grand total of at least 1½ million tons of this material has been produced and the savings effected to the user represent a sum which cannot be far short of £30,000,000 sterling; in fact, it has made certain engineering problems possible which otherwise could not have been carried out at all.

Another of the Hadfield inventions is Low Hysteresis Steel. The total saving to the world since the introduction of this material has probably now considerably exceeded 50,000,000 tons of coal, that is in fuel alone, to say nothing of the saving in the construction and service of Transformers and other electrical apparatus. It was in Shefield where the first practical application was made of this steel by Mr. S. E. Fedden, M. Inst. C. E., General Manager of the Sheffield City Corporation Electrical Supply Department, in the years 1903, 1905 and 1906.

Dr. T. D. Yensen, of the Westinghouse Electric and Manufacturing Company's Research Laboratory, stated in 1921 that the total saving already effected to the world by the Hadfield Low Hysteresis material in reducing energy loss, saving in copper, better apparatus and other conditions, amounts to not less than 340 million dollars (about 80 million pounds sterling), a total saving of fully enough to build the Panama Canal.

Hadfields War Developments

The quality and strength of other special steels has also been developed at the Hadfield Works to a remarkable degree, as exemplified by the wonderful performance of their armour-piercing projectiles which are made by them up to 18" calibre and are capable of perforating the thickest and most tough type of hard-faced armour afloat. The output capacity during the war of large armour piercing projectiles, of 12", 13.5", 15", and 18" calibres was on an enormous scale — nearly 1,000 per week.

The firm, known as Hadfields Ltd., was originally founded by the late Mr. Robert Hadfield, and has been developed into the present-day great establishment which is one of the most widely known steel-making organisations in the world and one particularly prominent in the special steel field. This has been accomplished under the direction of the Chairman, Sir Robert Hadfield, Bt., F.S., M. Inst. C.E., and his colleagues, Messrs. A. M. Jack, M.Inst.C.E., P. B. Brown, M Inst. C.E., Major A. B. H. Clerke, late R.A., and other Directors.

During the war, no less than 15,000 employees were at work. Hadfields undertook some of the most difficult and complicated products of the war, including their famous Armour-Piercing Shell, the successful production of which is probably one of the most difficult of all metallurgical problems.

The total area of the present works is 214 acres, of which no less than 51 acres are occupied by buildings. In the various Hadfields Steel Foundries there are no less than 12 acres of moulding floor space.

Great progress has been made at the East Hecla Works, Sheffield, in changing over to peace production, which has been accomplished without the waste of a single building. Messrs. Hadfields are now in an excellent position for dealing with post-war work, that is general commercial work, including the production of steel castings and forgings of all kinds on a very large scale. Their steel foundry buildings alone occupy a total area of no less than 20 acres. The Hadfield Works are equally equipped for furnishing special alloy steels for automobile and aeroplane work. Hadfields claim specially high quality for their steel because in the manufacture of their ingots they employ the Hadfield Sound Steel System which ensures perfectly solid rolled blooms, billets or rails, free from unsoundness, piping and segregation; while at the same time yielding a higher percentage of finished steel than that obtained by the ordinary methods. This patented system therefore enables higher quality material to be obtained with cheaper cost of production, a combination of results not often found.

Hadfields steel-making facilities comprise a plant of the most modern type of Open Hearth Steel Furnaces having an output capacity of about 1,200 tons per week, together with an electric furnace plant which during the war melted not far short of a thousand tons of steel per week. With their further special steel plant for producing steel under the Hadfield System, their grand total output capacity of steel reaches the considerable figure of 200,000 tons per annum.

It is only fitting that this organization, after devoting so many years to the production first of sound steel castings and ingots and secondly of Manganese, Low Hysteresis and other special steels in the form of castings and forgings of all types, should add the rolling and forging of special alloy steels to their other facilities.

New Rolling Mills

With this end in view Messrs. Hadfields have recently laid down three very complete electrically driven Rolling Mills, including a Reversing 28" Blooming and Finishing Mill, and 11" and a 14" Bar Mill, all of the most modern and improved types. The two smaller Mills are used for rolling billets to the various commercial sizes of round and square bars. They have proved very useful also for the production of special alloy high tensile for motor-cars and commercial vehicles, spring steel and other special steels. The new 28" Mill is the first having for one of its main objects the production of "Era" (Trade Mark) Manganese Steel Rails of various sections.

The total area covered by the new Rolling Mill scheme is 175,000 square feet or four acres, the Rolling Mill Shop itself occupying an area of 80,000 square feet or 1.75 acres. If the area of the smaller Mills is also included the total space covered is considerably over five acres. The building is equipped with travelling cranes of 20 tons and 35 tons capacity.

The Open Hearth ingots are conveyed hot to the Rolling Mill Building. The Furnaces and Soaking Pit embody all the latest modern improvements, and are of the gas fired, reversing regenerative type. The gas for the continuous furnaces and soaking pit is supplied by five gas producers, each capable of gasifying 10 cwts. of coal per hour. A gravity roller track links the soaking pit with the continuous furnaces. The main control platform is on the approach side, spanning the entire width of the Mill.

The mill is capable of rolling down 15″ square steel ingots 5′ long having a weight of 25 cwts. and reducing at one heat to 2½″ square billets. The normal output will be approximately 1,500 tons per week, or say 15 tons per hour, with a maximum output of 20 tons per hour for occasional short periods. The Mill will also roll Hadfield "Era" Manganese Steel ingots into rails up to the heaviest section in demand, having a maximum length of about 55′ rolled.

The 28″ Mill comprises one cogging and one finishing stand. The cogging rolls are 28″ in diameter and 7′ long and the finishing rolls 28″ in diameter and 6′ 6″ long. The total weight of the Mill is about 1,600 tons, that is including the electrical equipment, weighing approximately 400 tons. The main rolls of steel were manufactured by Messrs. Hadfields and are of their special quality forged steel with machined fluted wobbler ends. The hydraulic shears are of the up-cutting type complete with hydraulic intensifier arranged for a maximum power of 1,000 tons and capable of shearing "Era" Manganese Stell blooms when hot up to 10″ square. The hot saw is of the horizontal sliding type arranged with a blade of 60″ diameter and driven by a 75 h.p. motor.

The Mill motor has a rating of 3,200 h.p. and a maximum rating of 11,600 h.p. It is capable of exerting a constant torque of 125 tons feet from standstill to 60 revolutions per minute in either direction, and gives a constant horse-power of 3,200 between the speeds of 60 and 120 revolutions per minute. The overload capacity corresponds to a torque of 453 tons-feet between stanstill and 60 revolutions per minute; and 11,600 h. p. between the speeds of 60 and 120 revolutions per minute.

The cast steel flywheel, which was made by Messrs. Hadfields, is of the built-up type, 11′ 6″ in diameter and weighing 30 tons. The flywheel set, which consists of 1,800 h.p. 3-phase motor and on the same shaft two dynamos of 6,000 h.p. and farther along the shaft a 30-ton flywheel, is interposed between the power lines of the Sheffield Corporation and the main Mill Motor in order to supply the large machinery demand for power. The main Mill Motor is capable of being reversed from full speed in one direction to full speed in the other direction in three or four seconds.

The necessary appliances for carrying out the requisite treatment of the Hadfield "Era" Manganese Steel rails are arranged at the side of the ingoing runout by which the rolled material is conveyed to the saw. A noteworthly feature is an electrical telegraph system established between the control platform and the electrical equipment house by which orders can be communicated between the Mill Driver on the platform and the attendant in the electrical equipment house.

The hydraulic water service to the Mill is arranged for a working pressure of two tons per inch and is supplied by a set of three throw pumps driven by a 175 h. p. motor. The floor surrounding the Mill is finished off in a neat manner, the live roller gear, which at the Finishing Mill is 320 feet long, being below the floor, and the latter presenting an even plated surface all over with the exception of the live rollers which necessarily project slightly above the floor level. Provision is made for turning the main rolls in one bay of the Mill where there is ample space for the storage of the rolls.

There is no more modern plant of its kind either at home, in America, or elsewhere, and the Directors are to be congratulated upon the success attending their efforts.

PREHEATING OF CAST IRON AND STEEL FOR WELDING

Lower Temperature Recommended for Iron

In order to compensate for the lower melting point of cast iron as compared with steel, the Metal and Thermit Corporation, New York, recommends that in preheating cast iron sections preparatory to Thermit welding them, these sections be heated only a little more than necessary to show color, such as a dull red heat. If this advice is followed a quieter pour will be obtained and the fusion will be just as perfect. This practice has now been tried successfully in numerous cases, the most important case being a Thermit weld on a large cast iron press head which required 1,100 lbs. of Thermit. The weld was absolutely perfect, with good fusion to the extreme of the edge of the collar, although the cast iron section was heated only to a dull red heat.

It is believed that this point is very important to bear in mind and that operator will find that it will overcome possible difficulties which they may be experiencing in cast iron welding. One might suppose that as the cast iron of the parts being welded is not quite so fully expanded at this lower temperature there might, therefore, be a slightly greater tendency for hair-line cracks to appear in the Thermit steel collar perpendicular to the line of break. In actual practice, however, this has not been found to be the case, probably because of the fact that the expansion curve is much greater up to a red heat than it is from the red heat to the white heat and that the sections are, therefore, practically fully expanded at this dull red heat. It is certainly also true that the Thermit steel at first heats and expands the sections with which it comes in contact and, therefore, the slight difference in preheating is negligible.

Hans Renold of Canada Limited, 11 St. Sacrement St., Montreal, advise that their parent company have been successful in securing the contract for all the Chain Drives in connection with the South African Government scheme for handling, storage and shipment of South African grain. In addition to the terminal elevators at Capetown and Durban, this order includes thirty-four Country Station Elevators which will be built by Messrs. A. W. Menkins Company of New York City. This contract totals 272 Renold Silent and Bush Roller Chain Drives, which is said to be one of the largest, if not the largest, single contracts ever given for Power Transmission Chain Drives in grain elevators.

British Iron and Steel Institute

AUTUMN MEETING AT YORK

BY ROLAND H. BRIGGS

The four days Autumn Meeting of the Iron and Steel Institute was held in York from September 5th. to 8th. In addition to technical and social visits to important Works and places of interest in the district, the following papers were read at the meeting. *Air hardening nickel-chromium steels*, by L. Aitchison; *Nitrogenisation of iron and steel by sodium nitrate*, by L. E. Benson; *A Brinell machine attachement for use with small specimens;* by E. D. Campbell; *A preliminary magnetic study of some heat treated carbon steels*, by E. D. Campbell and Johnson; *Experiments on the flow of steels at a low red heat with a note on the scaling of heated steels*, by J. H. S. Dickenson; *An investigation on the factors influencing grain and bond in moulding sands*, by C. W. H. Holmes; *The manufacture and treatment of high-speed steel*, by H. K. Ogilvie; *Modern blast furnace practice*, by A. K. Reese; and *The diminution of lag at Arl through deformation*, by J. H. Whiteley. A paper on *Reversing cogging mills, their drives and auxiliary equipment*, by G. A. V. Russell, was withdrawn at the last moment on account of serious inaccuracies occurring in the pre-print.

Modern Blast Furnace Practice

The importance of the mechanical and physical conditions of the materials charged into a blast furnace was dealt with by Mr. Reese. A uniformity of chemical reactions as near as it can be obtained is essential, and also a uniformity of the physical movement of the materials throughout the whole cross-section in every zone of the furnace. Uniformity in the size and density of the materials charged, and a sufficient blast volume to produce the condition of a plenum throughout the whole furnace interior are also required.

While it is not possible to get perfectly uniform size and density with fuel, flux and ore, something approaching it can be obtained by proper preparation of the materials. Uniformity of size tends to uniformity of distribution, but it must be small size so that economy of operation may be obtained. Rapidity of action is largely dependent on the rapidity of combustion of the fuel, and it is preferable that the fuel lumps should not exceed 4 to 6 inches in size. The physical quality and chemical purity of the coke are of the greatest importance, which should be strong but not of great density, and low in ash and sulphur. It should be thoroughly screened to free it from smalls, and should be of medium cellular structure. A combination of strength and porosity is what is required. The higher the carbon content the greater its efficiency, and the careful washing of coal tends greatly to the satisfactory production of coke for blast furnace purposes. The formation and melting of blast furnace slag is estimated to require 25% of its weight in fuel, so that for every cwt. of slag produced from coke ash, 1/4 cwt. of fuel is lost as far as iron ore smelting is concerned.

Most iron ores as received from the mines range from fines to large lumps, and different ores vary greatly in physical characteristics. The degree of reducibility of an iron ore depends primarily upon its density, a characteristic which is not readily altered, except with dense ores containing high percentages of protoxide of iron (magnetite), the reducibility of which may be increased by subjecting them to roasting process is an oxidising atmosphere. But the rate of reduction can be materially increased by increasing the surface area exposed to the action of the reducing agents, by breaking the lumps into small pieces, as far as this can be done without the production of an excessive amount of fines. As a rule the smallest pieces produced will be larger than fines, and therefore not deleterious.

Fines may be increased to a suitable size for the blast furnace by briquetting, modulising and sintering processes, each of which yields a satisfactory product. The last mention is the most modern and is becomming very popular. The flux, limestone or dolomite, should be broken as nearly as possible to uniform size not exceeding 4 to 6 inches. Mr. Reese has used oyster shells alone with quite satisfactory results, except for the objectionable smell. He is a strong advocate of "dry blast" for modern furnaces.

In the furnace design, a shaft batter of 1 in 13½ to 15, a low bosh, a large hearth diameter, and a steep bosh angle, are the principal essentials. The upper section of the furnace or throat is usually cylindrical in shape and extends to from 20 feet to 25 feet below the furnace top or 12 feet to 17 feet below the stock line, the highest point to which the furnace may be filled. Throat diameters are restricted in modern furnaces of 85 feet to 95 feet in height to from 15 to 17 feet, the controlling factors being the other dimensions such as hearth diameter, bosh diameter and height.

The continued lowering of the top of the bosh followed the continued attempts at faster rates of driving for larger outputs, until a bosh height of 10 to 12 feet above the top of the crucible has been adopted in 85 to 95 feet furnaces as compared with as much as 30 feet in the old designs. The bosh diameters for this size of furnace will be from 20 to 23 feet with a bosh angle of about 80 deg., while in earlier designs this angle was anything from 68 to 74 deg. Hearth diameters are now normally from 16 to 18 feet, and in one case this dimension has reached 20 feet 9 inches.

Electric High-Speed Steel

Mr. H. K. Ogilvie described the manufacture of high-speed steel in the basic lined electric furnace and the subsequent heat-treatment of the steel. The charge in the electric furnace may consist entirely of high-speed steel scrap together with a small amount of turnings. The latter should be heavy and clean and should be placed under the electrodes and on top of the scrap until a bath is formed. Where a large amount of tungsten steel turnings have to be used up, it is preferable to add them gradually to the charge after it has been melted, but it is very much more economical to use only good scrap, heavy clean scrap with high tungsten content, and to reject light and rusty turnings. The attempt to make good high-speed steel from turnings alone is not usually commercially possible in Britain.

When good scrap is charged the melting slag is comparatively clean and need not be removed, and the sample for analysis can be drawn as soon as the bath has been stirred up. During the next hour, while waiting for the desired content of carbon, tungsten, chromium and vanadium, a heavy lime slag should be carried without getting the metal too hot. A small amount of lump ferro-silicon may have to be thrown into the bath to deoxidise the steel completely, and the slag should be kept as white as possible, taking care that it is heavy enough to prevent the coal or ground electrode which is sprinkled on it from passing through into the metal. During this time most of the sulphur is removed from the steel.

By the time the metal is ready to pour the carbon, tungsten and chromium should only be slightly reduced but most of the vanadium will have been removed. The necessary amount of crushed ferro-tungsten and ferro-chromium is added as soon as the analysis is obtained, and the temperature of the steel is gradually increased. When the bath is in good condition enough, ferro-manganese is thrown in to give about 0.2 per cent. manganese, and five minutes later the ferro-vanadium may be added in a bag and well rabbled under the slag. The furnace should be tapped within the next ten minutes if the samples are quiet and the temperature sufficiently high, and no additions of aluminum or any deoxidising compounds should be made to the ladle or moulds.

The ingots for each melt should be about the same size, and octagon moulds are the best. Casting should be done from the top of the mould, having the metal in the ladle hot enough to permit the slag to rise to the surface, and as small a nozzle should be used as will pour the whole heat at such a rate that lapping of the ingots is just avoided, and no crust permitted to form on the surface of the steel as it rises in the mould. The ingots should not be allowed to get quite cold, but should be transferred to the reheating furnace while they are still between 200 and 300 deg. C., and if the ladle and moulds have been kept clean, a quick examination is all that is necessary before heating for forging. Very careful examination of the billets, after cooling slowly, should be carried out, and the surface cracks or other flaws removed by grinding.

Large thin cutters should not be made direct from forged bars unless the bore of the cutter is extremely wide. It is better to use a medium sized ingot and to forge it to 4 inches or 5 inches round. A blank cut from this is then thoroughly forged until the required diameter is obtained.

The usual hardening practice consists of quenching the part in oil from a temperature of 1250 to 1300 deg. C., and to temper it either in an oil bath at 220 deg. C. or in a salt bath at 600 deg. C. In certain cases the tool may be hardened in an air-blast or may be allowed to cool normally in the air, depending chiefly on the size and design and whether slightly additional sealing may be disregarded. A 14 per cent. tungsten steel with about 0.65 per cent. of carbon and 4.5 per cent. of chromium with or without a small percentage of vanadium gives satisfactory results for normal work, but for very heavy duties an 18 per cent. tungsten steel having 0.6 per cent. carbon and 4 per cent. chromium with 1 per cent. vanadium hardened in air or oil at 1300 to 1310 deg. C. and tempered at 590 to 610 deg. C. will give the best results.

Nickel-Chromium Steel

Dr. Leslie Aitchison and Mr. R. G. Woodwine described the air hardening of nickel-chromium steels, and the importance of the alterations of volume which take place during the heating and cooling of the metal. From the experiments that have been carried out by these two investigators it is made clear that with nickel-chromium steels the expansion that should be produced at the critical range during the cooling from the hardening temperature is not completed during the slow cooling employed, and that reheating to quite low temperatures induces a further expansion. It has further been demonstrated that further reheating to low temperatures brings about a contraction, and that prolonged heating at low temperatutres induces still further contraction.

Reheating to intermediate temperatures (from 300 to 500 deg. C. induces a similar initial expansion and then a contraction, and reheating to 600 deg. C. induces a contraction. The smaller initial expansion at the intermediate temperatures is likely to be the resultant of the expansion and contraction proceeding simultaneously. The total contraction brought about at temperatures up to 200 deg. C. by repeated heating and cooling is less than that similarly produced at higher temperatures. The maximum contraction brought about in any way, at all the different temperatures, is the same in amount.

Moulding Sands

Mr. C. W. H. Holmes, B. Met., read an intersting paper on the factors influencing the grain and bond in moulding sands. Extensive investigattions were carreid out in this connection by Mr. Holmes, and from the results obtained it was made clear that the mechanical and physical properties of sands for grey iron founding are of equal importance to the chemical analysis. The bond adsorption value obtained on the raw sand may be greatly modified by mechanical treatment, and the most successful moulding sands contain both static and mobile bond. An appreciable degradation of the grains of a moulding sand occurs during the mechanical preparation as usually effected, and the bond distribution factor is a characteristic of moulding sands which is of great importance in view of the excessive degradation which may be caused by prolonging milling beyond the time needed to effect the optimum distribution. No single test is sufficient from which to judge the practical value of many moulding sands.

Nitrogen in Iron and Steel

Mr. E. L. Benson described some experimental work he had carried out on specimens of armco iron and steels of varying compositions to investigate the nitrogenisation caused by sodium nitrate. The specimens were annealed in a salt-bath at a temperature of 500 deg. C. for varying lengths of time, ad subsequent microscopic examination showed that most of the specimens so treated had developed a structure within the ferrite grains similar to that generally associated with the presence of nitrogen. The structure occurred as plates or lines along the cleavage planes of the ferrite grains, or occasionally along the grain boundaries. The matter was further investigated and it was clearly demonstrated that the specimens had become nitrogenised through being annealed at a temperature of 500 deg. C. in a salt bath containing sodium nitrate.

Forging Retards Formation of Pearlite

In Mr. J. H. Whiteley's paper on the dimunition of lag at Arl through deformation, experiments were described in which it was shown by both hammering tests and bending tests that lag at Arl can unmistakably be diminished by slight deformation. In two instances the pearlite had not even begun to form in the unhammered piece, while in the hammered specimens the change was well on the way to completion. The bending tests showed that at the bend pearlite was always present, but in the limbs, where the metal was not disorted, the structure consisted almost entirely of ferrite and martensite.

IRON ORE PER CAPITA IN U. S.

The Bureau of the Census has issued its report on "Iron ore," as part of the Fourteenth Census of the United States (1919). From this publication it appears that the per capita output of iron ore in the year 1879 was 0.13 ton for a population of 50 millions. This went up to 0.56 ton for a population of 92 millions in the 1909, and to 0.58 ton for a population of 106 millions in the year 1919. Minnesota and Michigan are the leading producers among the different states. In the year 1901 Minnesota attained pre-eminence over Michigan and has held it by large margins ever since. Alabama comes third, with New York fourth. Pennsylvania lost the leadership to Michigan early in the eighties.

American Electrochemical Society Meeting in Montreal

(Daylight Saving Time exclusively in this Program.)

The Headquarters will be at the Windsor Hotel, Dominion Square.

Local members of the Society of Chemical Industry, Engineering Institute of Canada, Canadian Institute of Mining and Metallurgy, the faculty staff of McGill University and of Montreal University (Ecole Polytechnique), are cordially invited to attend the meetings and entertainments without formal introduction. They will kindly register at the Society's desk.

Guests, after being introduced, may register and attend the sessions and the lecture Thursday evening. Other courtesies will be extended them by the Local Committee and officers of the Society. Applicants for admission to the Society who have paid the entrance fee may register at the meeting as members and wear the member's badge.

Meeting Places

The technical sessions Thursday morning and afternoon and Friday morning and afternoon will be held in the Auditorium of the Windsor Hotel.

The illustrated lecture by Professor A. S. Eve on "The New Philosophy of Physics" will be given on Thursday evening, at 8 o'clock, in Macdonald Physics Building, McGill University, within ten minutes' walk from Windsor Hotel.

The Smoker in charge of Section "Q" (Chairman, Fred. Brown) will be held in the Windsor Hotel on Friday evening.

Social Features

On Friday evening an old-fashioned Smoker will be given by the local committee at the Windsor Hotel.

Industrial Plants in or Near Montreal

St. Lawrence Sugar Refinery Company.
Canada Cement Company.
Imperial Oil Company.
Dominion Engineering Works.
C. P. R. Angus Shops.

Members and guests intending to visit one or more of the above plants will kindly advise the local committee or registrar upon arrival at Montreal.

Trip to Shawinigan Falls

There will be a special private train to Shawinigan Falls, leaving Windsor Station Friday at 11:30 at night, arriving at Shawinigan Falls at 7:30 A.M. The members will have a rare opportunity to inspect the following industrial plants:

Belgian Industrial Company.
Canada Carbide Company.
Canadian Carborundum Company.
Laurentide Power Company.
Laurentide Pulp & Paper Company.
Shawinigan Water & Power Company.

Members intending to take this trip who have not already notified the Secretary by mail are kindly requested to notify the registrar immediately upon arrival at Montreal. Information concerning the industrial visits will be obtainable at the registrar's desk.

Entertainment For Ladies

Thursday afternoon—sight-seeing trip. Details at the Registrar's desk.

Thursday evening, the ladies will attend the lecture by Professor Eve at McGill University.

Friday afternoon the ladies are invited to tea at the Golf Clubs.

For Friday evening a theatre party has been arranged.

Wednesday, September 21, 1922

6:00 P.M. Registration begins at Windsor Hotel.

Thursday, September 21, 1922

10:00 A.M. Session for reading and discussion of papers.

Norman B. Pillings: *Effect of Heat Treatment on the Hardness and Microstructure of Electrolytically Deposited Iron.*

R. P. Neville and J. R. Cain: *The Preparation and the Mechanical Properties of Vacuum Fused Alloys of Electrolytic Iron with Carbon and Manganese.*

Ralph B. Abrams: *The de-zincification of Brass.*

Walter G. Traub: *Electroplated Zinc and the Diffusion of Electro-deposits into Zinc.*

John T. Ellsworth: *The Effect of Single Impurities on the Deposition of Zinc from Sulphate Solutions.*

M. R. Thompson and C. T. Thomas: *The Effect of Impurities in Nickel Salts Used for Electro-deposition.*

Ernest A. Vuilleumier: *The Application of the Contracter to the Study of Nickel Deposition.*

12:45 P.M. Adjournment.

1:00 P.M. Meeting of Board of Directors at Lunsheon, Windsor Hotel.

2.00 P.M. Session devoted to papers and discussion on "*Industrial Heating*"; Bradley Stoughton, Chairman, Electrothermic Division.

Chas. P. Steinmetz: *The Underlying Principles of the Industrial Heating Problem.*

E. F. Collins: *Electric Heat; Its Generation, Propagation and Application to Industrial Processes.*

E. J. Smalley: *Principles of High Temperature Furnace Design.*

Wirt S. Scott: *Advantages of Industrial Electric Heating.*

M. A. Hunter and A. Jones: *Some Electrical Properties of Alloys at High Temperatures.*

C. E. Williams: *Resistivities of Some Granular Resistor Carbons.*

J. C. Woodson: *Heat Insulating Materials for Electric Heating Apparatus.*

Friday, September 22, 1922

9:30 A.M. Session on "*Industrial Heating*": Part II.

Frank W. Brooke: *Methods of Economically Handling Materials in Electric Furnaces.*

Wirt S. Scott: *The Development of Industrial Electric Heating for Low Temperature Enameling.*

E. T. Smalley: *Treatment of Ceramics.*

C. B. Gibson: *Electric Annealing of Malleable Iron.*

P. S. Gregory: *Electric Steam Generators and their Application.*

J. Murray Weed: *A New Type of Induction Furnace.*

A. Glynne Lobley: *A Simple Electric Crucible Furnace for Melting Aluminium.*

2:00 P.M. Reading and discussion of papers.

A. E. R. Westman: *The Relation between Current, Voltage and the Length of Carbon Arcs.*

Geo. A. Richter: *Manufacture of Carbon Bisulphide.*

O. C. Ralton: *Electrosmosis and Electrophoresis. Two Definitions.*
Alexander Lowy and Catherine M. Moore: *Electrolytic Oxidation of Isocugenol.*
Alexander Lowy and Henry S. Frank: *Electrolytic and Chemical Chlorination of Benzene.*
C. W. Vinal and L. M. Ritchie: *A New Method for Determining the Rate of Sulphation of storage Battery Plates.*
F. C. Mathers and Jacob W. H. Aldred: *Preparatino of Perchlorates by Heating Chlorates.*
H. C. P. Weber: *Changes in the Electrical Conductivity of Varnishes During Driving.*
C. J. Rodman: *Arc Action on Some Liquid Insulating Compounds.*
S. F. Howard and T. A. Martin: *The Difference Between the Half Sum and the Square Root of the Product when Weighing by the Method of Gauss.*

8:00 P.M. Smoker at Windsor Hotel.

11:30 P.M. Special Excursion to Shawinigan Falls. Train leaves Windsor Station at 11:30 P.M. The return train from Shawinigan Falls will arrive in Montreal on Saturday evening in ample time to permit members wishing to make connections for all through night trains to Toronto, Buffalo, Niagara Falls, Chicago, New York, Boston, Philadelphia, Washington, et al

RESEARCH WORK AND THE CHEMICAL ANALYSIS OF CAST-IRON

By H. J. YOUNG, F. I. C.

"All possible care must therefore be exercised in the initial stage, and the laboratory results examined and checked in the smallest detail."

"So much depends upon the process of analysis resting on an unassailable basis."

"In experimental investigation great attention must be given to detail. Where this is not fully realised, conclusions may be drawn from premises which are either incomplete or incorrect."

The above passages from Dreaper's "Notes on Chemical Research" have some considerable bearing upon the present position in the metallurgy of cast-iron and of ironfoundry practice.

Cast-iron, one of the most impure or, at any rate, one of the most intricately impure materials of commerce, is full of mysteries and contradictions. A study of the literature of cast-iron and its properties and manufacture will reveal this fact to an amazing degree. What is apparently proved by one worker is apparently disproved by another. Take the effect of sulphur, for instance, and it will be found that whilst one man says it is harmful another says it is beneficial, that whilst one pig-iron is commended for its low sulphur-content, exactly the opposite is the case of certain white irons which are equally commended.

The inquiring foundryman is unfamiliar with the difficulties of chemical analysis, as, indeed, are many analysts, and he does not appear to realise that an analysis has in itself no particular standard of accuracy. It all depends: and therefore thousands of analyses, though perhaps quite sufficiently good for their original purpose, are entirely valueless, and even misleading, as proofs of any theory or, possibly, of any fact.

Foundrymen are, for instance, faced with the problem as to why two pig-irons of apparently similar composition give castings of widely different properties. The most unscientific person would probably ask whether one can be certain that the compositions are similar, and in so asking would he indicate the vital point of the problem, and one that foundry workers have either over-looker or under-valued.

To determine beyond doubt whether two pig-irons or cast-irons do or do not possess precisely similar compositions requires greater accuracy, experience and knowledge than the ordinary analyst is to be expected to have. In the first place, the analyst will have to prove the accuracy of his method and of his way of working that method, and, in the second place, he will need to compare the results obtained by his method with those obtained by other methods; thirdly, he will need to investigate whether his method is applicable, with equal accuracy, to any iron of any composition; and, lastly, he will need to prove that the final result really represents the element he is estimating, or whether it includes other elements or compounds.

Of course, in everyday laboratory practice, this is not done, and in some laboratories it never has been done. One simply uses methods out of a book handled during earlier training. In many laboratories the methods, though good in themselves, are worked wrongly or in a slovenly fashion, or are applied to unsuitable purposes. It takes many years to train a man to be an accurate analyst, and there is no certainty that he will be one even after those years of training. It depends upon the training and upon the man. Some chemists say that analysts are born rather than made. Certainly it is the writer's experience that not one out of a hundred ordinary boys has the qualities essential to the making of an accurate analyst no matter how much training he may have — nothing like one in a hundred.

The object of this article is not to prove that there are analysts of differing calibre — that is already well recognised by chemists themselves — but to show that the value of any research upon cast-iron depends almost entirely upon the correct analysis of the specimens under investigation. Some years back one of our leading engineers caused to be prepared a standard sample of cast-iron, which he sent round to a number of laboratories of all kinds all over the country. The results were deplorably poor, and, in many cases, ludicrous.

Naturally, one can hear the foundryman say to himself, "Well, what does it matter if it does differ a little either way? It is merely splitting hairs to talk in this manner about an analysis." Thereby does the unscientifically trained man make an enormous mistake; the success or failure of most things depends more upon small matters than upon large ones, and that is as much true as regards foundrywork as regards anything.

A little, a very little, strychnine will turn a glass of water into a good tonic; a little more, a very little more, will turn the mixture into a dealy poison. In metals and alloys we know of quite a number of things with strychnine-like effects. Ask the metal-rolling trades what they think about minute impurities and small amounts of other additions (not impurities) — they will tell you that they are the principal things to think about in their trades.

In cast-iron it is not yet known what is and what is not important. It must be something exceedingly small that makes two irons have very different properties, even though their compositions are apparently similar

*From Foundry Trade Journal.

True, it may be something to do with inherent properties, but, on the other hand, it may be due to composition and, before accepting the former theory, it will be necessary to prove the latter.

The common analysis of cast-iron includes carbons, silicon, phosphorus, sulphur and manganese, and it is an exceedingly difficult analysis to make correctly, particularly in certain irons. The common analysis of cast-iron does not include titanium, copper, nickel, arsenic, chromium, tungsten, etc., to say nothing of the various gases and compounds of those gases; and, moreover, it is unfortunately true to say that the estimation of some of these things is, at the present time, very indecisive, and, in some cases, altogether impossible.

It is a brave man, and a rash man, who says that the properties of cast-iron do not depend upon composition, and he has got a great deal of work before him if he desires to prove his statement.

Considering one or two concrete and simple cases. Suppose two cast-irons are analysed for the ordinary elements, and one of them is found to contain 0.10 per cent. more silicon than the other, but is the same as the other in all else. Will anyone say that the 0.10 per cent. silicon does not matter and that the irons are precisely alike? Or suppose, instead of 0.10 per cent. silicon, the difference was 0.05 per cent. manganese, or 0.05 per cent. phosphorus, of 0.05 per cent. carbon, or 0.01 per cent. sulphur. Who can say what does and what does not matter? The writer knows of several foundrymen who say these things do not matter, but they are speaking without metallurgical training and are unaware of the possibilities.

Suppose it takes 0.13 parts of A to combine with 0.017 parts of B to form a compound AB; then it follows that, if there are 0.18 parts of A, there will be an excess of 0.05 parts; or, if there are 0.022 parts of B, there will be an excess of 0.005 parts of B. Then suppose that A or B happens to be like strychnine, does it not follow that the slightest excess over that required to form the compound AB will be beneficial or fatal to the result, and this even though the compound AB may, in itself, be comparatively inactive?

Let us therefore start at the beginning, and discover for a certainty the actual values of the various elements in cast-iron. A large job, no doubt, but if a number of enthusiasts work towards those ends, it will be not overhelming to anyone, however limited may be his facilities.

It will be understood that the above remarks are written for foundrymen rather than for trained chemists. The latter take an analysis with as much salt as is suitable for the brand, while the former are unable to judge the required amount, and are liable even to believe that an analysis — any old analysis — is necessarily a perfectly accurate measurement.

THE ANALYSIS OF SLAG

By "CELSIAN."

The following simple method of analysis for slags produced in making iron and steel, reproduced from the Foundry Trade Journal, may help in solving the problem of this long-neglected item in ferrous metallurgy. — Ed., I. & S. of Canada. . .

Few methods have been given in text-books for the rapid estimation of iron when conducting the analysis of slags.

In the analysis of slags from non-ferrous metals, care is usually taken that the constituents are so separated that more than one can be estimated at a time, thus economising the time expended. This has seldom been attempted when cupola or other iron slags are dealt with. One of the obstacles to rapidity usually encountered is the difficulty in bringing the slags into solution, as many of them r equire a preliminary fusion with potassium and sodium carbonates and other fluxes.

Rapid methods of dissolving slags in special acid mixtures have been worked out by several chemists, but usually little has been heard of the results obtained. The following method gives details of a rapid means of separating the constituents of the slag after the latter have been dissolved.

Method

This method may be applied when dealing with cupola, blast-furnace or steel (acid and basic) slags. The powdered sample of slag is weighed out and mixed with a fusion mixture composed of equal parts of sodium and potassium carbonates and about 10 per cent. potassium nitrate. This material is fused in a platinum crucible in muffle furnace, and the fusion when cold is extracted with water and a little hydrochloric acid. As the solution is to be evaporated to dryness, the least possible quantity of water and acid should be used. Where the slag is soluble in acids, it is boiled down to a low bulk with hydrochloric acid and a few drops of nitric acid. Further details of the methods used for dissolving the slag may be had from most text-books on analysis.

To the solution containing the dissolved slag and free silica, add sulphuric acid, evaporate the liquor to dryness and bake the residue on a hot plate. After cooling, add a few drops of surphuric acid and take up in boiling water, filter, and wash the mixed precipitate of calcium sulphate and silica till free from acid. The addition of alcohol to precipitate completely any remaining traces of calcium sulphate is scarcely necessary when dealing with a concentrated solution. The precipitate is then digested in a hot, strong solution of ammonium sulphate.

Calcium sulphate is soluble in the latter reagent, but the silica is left unaffected. The solution is filtered and washed, and the precipitate ignited and weighed as silica. The best results are secured by filtering the solution hot, and washing first with hot ammonium sulphate solution and then hot water.

A method has been suggested whereby the mixed precipitate of silica and calcium sulphate is first weighed on a tarred paper, after which the latter is washed out with ammonium sulphate and the silica ignited and weighed. By this means the percentage of lime can be obtained by difference, but in some instances the dried calcium sulphate is not rapidly soluble in ammonium sulphate, so that a great deal of time is often wasted.

Lime

The calcium sulphate is quickly re-precipitated by boiling the solution with a little sulphuric acid and adding about 10 c.c of alcohol before filtering. When little lime is present the solution requires to be settled before filtering; double-ribbed filters should be used. The precipitate is washed with water containing a little alcohol and the mass carefully dried and detached from the paper. After burning off the paper, the precipitate is added to the crucible and carefully ignited and weighed as calcium sulphate, from which the calcium

can be calculated. Care must be taken that no reduction takes place at too high a temperature in presence of any unburnt carbon of the paper, as the calcium sulphate may be partly converted to sulphide. The filtrate contains iron, aluminum, magnesium, and small quantities of phosphorus and manganese. The last two and the sulphur are much more rapidly estimated in a separate sample of the slag.

Alumina

To the filtrate from the lime-silica precipitate, add ammonium chloride and hydrochloric acid, and then neutralise the excess acid with sodium carbonate solution. Add a strong solution of sodium thio-sulphate in such quantity that it reduces all ferric salts to the ferrous state (the solution being rendered colourless). A further addition of thiosulphate is made, and the solution boiled till free from sulphur dioxide fumes. The hyposulphite is decomposed and aluminum precipitated as hydroxide. Filter the solution, wash with hot water, dry, ignite, and weigh as alumina.

Iron

To estimate the iron by the sulphide method is the most rapid, but as the remaining filtrate requires to be boiled for some time to free it from sulphide fumes, and a very large, bulky precipitate of sulphur requires to be filtered off, the estimation of magnesia is slower, and more time is required in the long run. The method of measuring the solution, dividing into equal halves, titrating the iron in one portion by dichromate or permanganate, and precipitating magnesium in the other is rapid, but cannot always be relied on to give accurate results.

Another method often adopted consists of oxidising the iron with nitric acid, and precipitating it with ammonia and ammonium chloride, after which the magnesium is precipitated by the usual phosphate method. As the iron has been reduced to the ferrous condition, use should be made of it in this state instead of reducing it, as a great deal of time is lost here unnecessarily.

The following method, although not giving very accurate results with the magnesium estimation, can be relied on to give a rapid approximate assay which is sufficiently accurate for all ordinary works requirements. The solution, after boiling with hydrochloric acid to decompose the excess hyposulphite, is titrated directly with standard potassium dichromate solution and the percentage iron oxide computed.

To the titrated solution, which is still hot, add a few cubic centimetres of strong suphurous acid solution. A green coloration will be formed if the dichromate has been reduced, it should be boiled for a few minutes to effect complete reduction. An excess of ammonium carbonate is then added, and the solution filtered and washed. Ammonium carbonate precipitates chromium and iron, the former as hydroxide and the latter as ferrous carbonate, while magnesium remains in solution, as there is an excess of ammonium chloride present.

Magnesia

The magnesia is estimated in the usual manner by adding excess of ammonia and ammonium phosphate, stirring, settling, filtering, drying, igniting and weighing as pyrophosphate. Acurate estimations of magnesia are seldom if ever conducted in ordinary works laboratories. To secure the best results the filtrate containing the magnesia should be evaporated to dryness and baked until all fumes of ammonium salts have been evolved. The cooled residue is dissolved in a little hydrochloric acid, treated with a moderate excess of ammonia and the magnesia precipitated with a sodium "hydrogen" phosphate solution after which it is allowed to settle for seeral hours before filtering.

In comparing the foregoing methods of estimating iron and magnesia with the standard methods, it should be remembered that the latter are not always adopted in works laboratories, modified analysis being generally preferred, which produce results in a shorter time. Any small quantity of the alkalies in the slag is estimated in the filtrate by the usual text-book methods.

Manganese and Phosphorus

Another sample of the powdered slag is weighed out and mixed with the same fusion mixture as before. Fuse in a platinum crucible, and after cooling dissolve out the mass with distilled water. No acid should be used here unless the mass shows signs of great insolubility, as it causes part of the silica to separate out. The solution is measured and divided into equal halves, or portions of known volume. To one portion add about an equal volume of concentrated nitric acid and heat to boiling-point. Add a few c.c.'s of the dilute solution of silver nitrate and then several grammes of ammonium persulphate. The nitric acid causes part of the silica to separate out, but it has no detrimental effects on the colour produced by the manganese. The solution is boiled on a water bath until the pink colour is fully developed, cooled rapidly and titrated at once with a standard solution of sodium arsenite until the colour disappears, leaving the solution tinted pale green.

Where little manganese is present, the colorimetric method may be applied, but the solution must not be filtered, as the silica is only incompletely precipitated and not granular, so that there would be a risk of it sticking in the filter. The titration with sodium arsenite is to be preferred to the colorimetric method.

Phosphorus is estimated in the other portion of the solution by applying the colorimetric method, as the ordinary gravimetric and volumetric assays could not be successfully used unless the silica was removed, which would take some considerable time. An excess of ammonium hydrate is added to the solution, together with a little ammonium chloride. The thick iron sludge is re-dissolved in nitric acid, heated to about 70 deg. C., and an excess of a 10 per cent. ammonium-molybdate solution added. After shaking well and warming on the hot plate, the yellowish liquor is transferred to an ore glass and compared with a standard phosphorous solution prepared in a similar manner.

The manganese and phosphorus can thus be estimated without resorting to the prolonged method of separating the silica first. The same procedure requires to be adopted for estimating manganese and phosphorus when dealing with slags soluble in acids, with a few exceptions.

In dealing with slags containing iron in both ferrous and ferric conditions, the ferrous oxide may be estimated in a portion of the liquor from the second fusion, in which cases the fusion mixture used must be free from nitrates or other oxidising material.

Manipulation

In conducting the foregoing analysis the two fusions are carried out together. The manganese and phosphorus assays are completed while the silica is igniting. The iron is estimated and magnesia precipitated while the alumina and lime precipitates are being dried. The magnesia is settled and filtered while the latter are being ignited and weighed. The magnesia is weighed last. By conducting the analysis in this manner the method will be found to be much more rapid and practically as accurate as the ordinary methods of analysing slags.

Safety Work at Sydney Mines and Mills

BY JOHN MOFFATT

Those who have been in close touch with the work of the Safety Department at the Sydney steel plant and the Glace Bay collieries during the past two years recognize that good work has been done and much progress made in the way of prevention of accidents. Being a comparatively new department with no statistics running back over a sufficient period of time for comparison, it is difficult to give an accurate statement of each year's work showing what has been really accomplished. Common observation assures us that the work is being carried on along right lines and only requires perseverance and "push" to achieve even greater success.

Safety a Psychological Affair

The amount of literature on safety work that is being published and circulated among the workmen of all large industries in all industrial countries is enormous. Educational campaigns are being conducted on the principle that "constant dropping wears away the rock". With this in mind and with the purpose of having the workmen permeated through and through with a thought that they are their own and their brothers' keepers, safety departments labour assiduously to awaken interest, arouse attention, and cause men to think.

All accidents, whether slight or serious, are calculated to make men think. This is Nature's way of arousing attention, and when reflection is sufficiently deep and strong, action is generally taken along lines of prevention. But it is not enough that men who have been injured should think and act; supervisers of workmen must do their share of it,—indeed they must be the leaders. Their thoughts must be expressed for the benefit of others passing along the same way. Their plain duty is to warn, and sometimes to command. Their relation to the Company which they serve and the general public demands that their experience be incorporated into the sum of human knowledge, that it may be used for the benefit of the whole human race. Hence we have new departments springing up, and whether we designate these under the head of safety, welfare, social or industrial, they are all part and parcel of the one division of industry that has to do with the human side.

Safety Pays

Just as cities and towns have come to recognize that vital statistics measure a distinct financial loss or again, as well as their standing in the scale of civilization, and likewise teach them that each child born must receive the best possible care that it may live and become a useful citizen, so large industries have come to see the financial loss sustained when a workman is killed or seriously injured and the discredit that follows when the accident rate is abnormally high.

The railway, steel, and coal mining industries are hazardous occupations. The catastrophes that sometimes occur in all these callings shock us and make us wonder if man will ever be able to master thoroughly the elements of danger which at times appear with lightning rapidity, do their deadly work, and pass on, leaving us for the moment dazed and doubtful of our own ability to cope with the forces we have discovered and set in motion and which we fail at times to control. The complexity of machinery in large industries leads to accident. This is recognized and men have set themselves to reduce the danger of working around these great machines. Organization, education and mechanical safeguards are the preventives used, and they have been found most successful. In the large steel works of the United States, good results have been obtained by these means and the accident rate has been greatly reduced. This has been brought about by the hearty co-operation of the employer and employee, working together with the one thought in mind that a complex industry with its great variety of machinery presents dangers that can only be overcome by the constant care and watchfulness of every man, from the gate keeper to the General Manager.

Safety in the Steel Plant

What these large works elsewhere accomplished, we can accomplish in Nova Scotia. If they have succeeded in large measure in preventing accidents by studying the causes of accidents, so can we succeed by following their example.

The steel workers of Sydney were among the first to recognize the importance of grappling with the safety question, and when, after placing Safety Guards on dangerous parts of machinery and hazardous places the management invited the workmen to form committees in the different departments to aid in safety work, there was a response that has brought about good results.

The steel plant can now be said to be fairly well organized, and through the system of forming committees from each department to work with the foreman and the Safety Inspectors for a period of six months, after which they retire in favour of new committees, the whole body of workmen is being gradually educated and imbued with the spirit of safety. The effect of this has been felt all over the works, and while there are still too many accidents, yet the number has been much reduced and in some departments has been reduced almost to zero.

Superintendent Bischoff, in a talk to the Safety Committee a short time ago, stated that there were three general causes of accidents; first, general conditions for which the management was largely responsible; second, the efficiency of the foreman in charge and his interest in the welfare of the men under him; third, the morale of the men themselves. The Company, he stated, must see that conditions in the works are made and kept as safe as possible; the foreman in charge of each department must see that workmen run no unnecessary risks, and must feel that he is largely responsible for accidents; while the workman who keeps continually getting hurt loses his morale and nerve and eventually becomes unfitted to carry on. Such advice as this from the General Superintendent of a large steel plant is calculated to show the workmen that the Company fully realizes their responsibility towards them.

Education the Principal Means to Safety

Some months ago safety roganization as a whole was dealt with in these columns, showing the work from the general committee down, and it is not necessary to repeat the story. Experience has taught that lack of organization is responsible for two-thirds of the accidents that occur. This being recognized, education was at once begun, and must be continued, and it becomes as much the duty of the management to see that the means

of education is provided, as it is the duty of the workmen to be willing to acquire it and assist in spreading it among his fellow-workmen. If sixty-six out of every one hundred accidents can be averted by knowing how to prevent them, why should they occur? Knowledge in all cases means life and health and soundness of body.

Miners Prefer First-Aid Stations

It is not always easy to enlist the sympathy and secure the support of workmen, even in their own interest. There may be various reasons for this attitude. The colliery workers, while invited like the steel workers to appoint safety committees, did not respond, but on the other hand many miners attended the first-aid classes and made themselves proficient in the art of giving first aid to the injured. This led to the erection of first-aid stations at every colliery. These are well equipped and are models of cleanliness. Injured workmen are beginning more and more to find their way to these stations, and before long they will be looked upon as part of the mine equipment and no colliery will be complete without a dressing station.

Mechanical Guards a Necessity

If education can account for two-thirds of accident prevention, safety guards account for the other third. Education has to do with the human element, safety guards with the mechanical side. Where the human element fails, mechanical skill assists. Trained intelligence may greatly strengthen that first great instinct within the human breast, self-preservation; but man's courage urges him to take chances. Safety guards are erected to discourage these gambling tendencies and to hinder all foolish attemps at such. True, before safety guards came into general use, the workman had no alternative than to take chances. Now he is deterred in every way. He goes to the emery wheel to sharpen tools or grind down some piece of machinery, but he must wear goggles. In handling electric wire, he must wear rubber gloves and be thoroughly insulated. And so through the whole works, as far as possible the machinery is safeguarded and the workman himself is rendered immune from accidents by intelligence, skill and all other known protectors.

Cost no Longer the First Consideration

Cost is not considered where life is to be protected. Safety comes first, quality second, and cost last. Thus we have an entire change from twenty years ago, when output was the first consideration, quality second and safety last.

While there may not be accumulated data by which comparisons may be made, there are outstanding proofs that we have progressed far and are making good headway. Compensation Board records shows that septic cases are not now so numerous and so serious as formerly. This is due to the improved sanitary conditions of the works and to treatment at the first-aid stations before the workman leaves the mine or the department in the Steel plant where he was injured. In the month of May, fifty-six men were treated at the first-aid stations at the collieries and in June forty-seven were attended. As blood poisoning sometimes arises from slight wounds, who can tell how many lives were saved, what suffering or financial loss was avoided by this first-aid treatment?

The First-Aid Stations

At some of the larger collieries, permanent men are placed in charge of these first-aid stations. But at other collieries some trained workman gives first-aid when the injured man reaches the surface. Many severe cases are now being skillfully cared for underground. A short time ago a miner was severely injured while at work. A fellow workman nearby attended to him and although the case was one where loss of blood would have caused death in a short time, the work of bandaging was so well done that he was taken straight to the hospital from the mine. Another case two days ago aptly illustrates what our miners are doing. A large flat slab of rock fell from the roof on three miners, pinning them underneath. All were severely injured. One man by the name of Dawe, usually a quiet person, when appreached by the rescuers told them to attend to the other two men first. When Dawe was examined it was found he had sustained a compound fracture of the leg above the knee. But one of the trained first-aid men was equal to the occasion and applied the splints as dexterously as if he had been an army surgeon. This case also passed on to hospital without having to be cared for at the first-aid station.

Accidents to Eyes Reduced

A class of accidents that has been greatly reduced on the steel plant is that of injury to the eyes. To-day serious cases of these rarely occur. This is largely due to the regulations of the plant that men chipping steel, breaking pig iron, or doing any other such work must have their eyes protected.

All accidents are investigated by the Inspectors and the causes ascertained. They are divided into two classes, preventable and non-preventable. The causes of preventable accidents may lie either with the manager or with the workmen. When these causes are made known, steps are taken to remove them. The safety department fills a large place in that it is free to discover and make known the cause of accident irrespective of whether the management or the employee is responsible.

PORT ARTHUR SHIPPING NOTES

By J. J. O'Conner

At noon on the 12th. instant, the steamer "Mathewston" slipped into her native element from the ways of the Port Arthur shipbuilding Company's yards, at Port Arthur.

The christening ceremony was performed by Mrs. A. E. Mathews, wife of A. E. Mathews, President of the Mathews Steamship Company, owners of the ship. A large number of invited guests attended the launching from Toronto, Montreal, Chicago, Duluth and New York, while the people of the twin cities at the head of the Lakes turned out in numbers never before seen at a launching at this yard. Everything worked like clockwork, and sharp on the minute set the great hull slid into the water to the strains of the Pasco Band, an organization composed entirely of employees of the Port Arthur Shipbuilding Company.

The ship has a d.w. capacity of 12,000 tons, is all steel, of the most modern type of construction, amply powered, and equipped with up-to-date handling facilities. The officers and crews quarters are fitted up with a view to the maximum of comfort and convenience, while the owner's cabins are luxuriously fitted, for the convenience of several guests.

Immediately after the launching, the ship was towed out of the dock and taken to the shear legs, where boilers and engines will be installed and the final touches given to what is said to be the last word in Lake shipbuilding.

The work of construction was under the immediate direction of Mr. John H. Smith, manager of the Port Arthur Shipbuilding Company, who has every reason to feel gratified over the out-turn.

The function was suitably wound up by a luncheon at the Prince Arthur Hotel, followed by a cruise around Thunder Bay.

Factory Mutual Insurance

BY FREDERICK T. MOSES

Vice-President and Engineer Firemen's Mutual Insurance Company

Eighty-seven years ago a group of Rhode Island manufacturers, unable to secure relief from the extortionate rates charged by stock fire insurance companies, associated themselves and formed the first Factory Mutual Insurance Company. The immediate success of their efforts attracted the attention of other New England manufacturers and rapidly led to the formation of additional companies, both in Rhode Island and in Massachusetts. For a number of years their underwriting was confined to New England, but as the results achieved by the organization became known, they were asked to extend their work to other states and to Canada. The system has grown to a point far beyond the thought of its founders, and today is the strongest, most progressive underwriting organization in existence.

The public looks upon the Factory Mutual system as an organization which became successful thru the selection of risks from a class in which there was little or no fire hazard. This impression is not the correct one. The Mutual Companies originated with textile plants, a class so hazardous as to be almost uninsurable. The frequent fires and heavy losses brought forth an intensive study of the hazards involved, founded the Mutual system of inspection, and resulted in bringing the textile mills to the point where to-day they are considered preferred risks. This is in direct antithesis to the Stock insurance point of view that the rate should be made to fit the hazard, the underwriter acting merely as a distributor of losses.

The fire prevention department of the Mutual Companies has grown rapidly. New methods of manufacturing, the introduction of electrical machinery, and high speed methods of production developed in the mechanical industries have all presented new problems whose solution has necessarily kept pace with industrial development of the country. Our engineering work to-day involves an annual expenditure of about $75,000. Large insurers, as for example the International Harvester Company and the General Electric Company, have frequently stated that they consider the fire prevention service of the Mutual Companies of greater value than the entire cost of insurance. Systematic inspections of each plant are made four times a year, and the services of special engineers are available to the assured at all times. Special investigations of this nature have been extended to such subjects as the prevention of dry rot in factory timber, the prevention of fire in solvent naphtha in rubber spreader rooms, the control of celluloid fires by automatic sprinklers, the prevention of fire in pulp wood piles, the prevention of dust explosions in grain elevators and starch factories. The laboratories maintain a staff of engineers constantly engaged in the investigation of new devices for fire prevention, together with supervision over the manufacture of such materials.

The Inspection Department has also developed a quick and accurate method of appraising factories. This work is done without cost to the policyholder. Such apprasials fulfill practically all the requirements of those made by independent appraisal organizations. They have been accepted for tax purposes and as a basis for bond issues. They offer a further advantage of furnishing *before the fire* a satisfactory base for the adjustment of a loss.

The field covered by the Factory Mutual Companies is comparatively limited in extent. Insurance is written only on factories and warehouses of superior construction, protected with automatic sprinklers. Liability is not assumed within the closely built up sections of cities, except to a very limited extent, and then only on fully protected reinforced concrete buildings. The moral hazard is eliminated by a careful preliminary scrutiny of the business record and financial integrity of the prospective policyholder and by a periodical review of these considerations by the officials of the Companies. So carefully has this feature been observed that during the past two years, when general fire losses in the United States and Canada were the greatest in their history — except in the year of the San Francisco conflagration — those of the Mutual Companies were the lowest ever known.

The management of the Companies is in the hands of a group of officials elected annually by the Boards of Directors, who are themselves policyholders, and so necessarily vitally interested in the success of the companies.

Rates in these Companies are based on the loss cost experience with various classes of manufacturing. In arriving at the rate on a risk, comparison is made with other plants as to construction, occupancy, protection, location and exposure. Each risk in the same class takes the same rate, thus insuring a fair and equal distribution of cost.

The following table is taken from the annual report of one of our Companies and is fairly representative of the results obtained by all. The cost of insurance is given in ten year periods and shows the results of constantly improved methods of protection and inspection.

Period	Annual Cost of Insurance — Cts. per $100
1850-1860	43.73
1861-1870	27.95
1871-1880	25.38
1881-1890	22.71
1891-1900	14.36
1901-1910	6.77
1911-1920	6.34
1921-	3.23

The financial standing of the Mutual Companies is not correctly shown by the usual published financial statements, as these are issued in the form prescribed by various insurance departments. The large advance premium collected by these Companies creates for the payment of losses a fund over ten times as great in proportion as is available in the largest stock fire insurance companies. The relative loss paying ability of the Factory Mutuals is the highest of any insurance organization.

Policies are written on a broad and liberal form, generally without coinsurance restrictions.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this journal, who in all probability, will be able to give the desired information.

Accumulators, Hydraulic:
Smart-Turner Machine Co., Hamilton, Ont.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Air Compressors:
R. T. Gilman & Co., Montreal.

Aluminum:
A. C. Leslie Co., Ltd., Montreal.

Angle Bars:
Steel Company of Canaa, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Barbed Wire Galvanized:
British Empire Steel Corporation, Ltd.
Steel Company of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Anchor Bolts:
Steel Company of Canaa, Ltd., Hamilton, Ont.

Axles, Car:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
United States Steel Products Co., Montreal.

Axles, Locomotive:
British Empire Steel Corporation, Ltd.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
United States Steel Products Co., Montreal.

Barrel Stock (Black Steel Sheets):
Seneca Iron & Steel Co., Buffalo, N.Y.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bars:
British Empire Steel Corporation, Ltd.
Dominion Iron & Steel Coy., Ltd., Sydney, N.S.
United States Steel Products Co., Montreal.

Bars, Iron & Steel:
British Empire Steel Corporation, Ltd.
Manitoba Steel & Iron Company
Canadian Western Steel Co., Calgary, Alta
Dominion Iron & Steel Coy., Ltd., Sydney, N.S.
Ferguson Steel & Iron Co., Buffalo, N.Y.
The Steel Company of Canada, Hamilton, Ont.
Beals, McCarthy & Rogers, Buffalo, N.Y.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Canadian Drawn Steel Co., Ltd., Hamilton, Ont.
Canadian Tube & Iron Co., Ltd., Montreal.
Leslie, A. C. & Co., Ltd., Montreal.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bars, Steel:
British Empire Steel Corporation, Ltd.
Dominion Iron & Steel Coy., Ltd., Sydney, N.S.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Billets, Blooms and Slates:
British Empire Steel Corporation, Ltd.
Dominion Iron & Steel Coy., Ltd., Sydney, N.S.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Steel Company of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Belting, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Benzol:
British Empire Steel Corporation, Ltd.
Dominion Iron & Steel Coy., Ltd., Sydney, N.S.
Steel Company of Canada, Ltd., Hamilton, Ont.

Binders, Core:
Hyde & Sons, Montreal, Que.

Bins, Steel:
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto
Toronto Iron Works, Toronto, Ont.

Black Steel Sheets:
B. & S. H. Thompson & Co., Ltd.
Seneca Iron & Steel Co., Buffalo, N.Y.
Leslie & Co., Ltd., A. C., Montreal, P. Que.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Blooms & Billets:
Algoma Steel Corp., Ltd., Sault Ste. Marie.
British Empire Steel Corporation, Ltd.
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Dominion Iron & Steel Coy., Ltd., Sydney, N.S.
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Boilers:
Sterling Engine Works, Winnipeg, Man.
R. T. Gilman & Co., Montreal.

Bolts:
Baines & Peckover, Toronto, Ont.
Steel Co. of Canada, Hamilton, Ont.
Canadian Tube & Iron Co., Montreal, P.Q.

Bolts, Railway:
British Empire Steel Corporation, Ltd.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Bolts, Nuts, Rivets:
Canadian Tube & Iron Co., Ltd., Montreal
Steel Company of Canada, Ltd., Hamilton, Ont.

Box Annealed Steel Sheets:
B. & S. H. Thompson & Co., Ltd.
Seneca Iron & Steel Co., Buffalo, N.Y.
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Brass Goods:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Brick-insulating:
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.

Bridges:
Hamilton Bridge Works Co., Ltd., Hamilton.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.

Brushes, Foundry, Core:
Hyde & Sons, Montreal, Que.

Buildings, Metal:
Pedlar People, Limited, Oshawa, Ont.
Hamilton Bridge Works Co., Ltd., Hamilton.

Car Specialties:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.

Carriers:
Canadian Mathews Gravity Carrier Co., Toronto, Ont.

Gaskets, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Cast Iron Pipe:
National Iron Corporation, Ltd., Toronto
Hyde & Sons, Montreal, Que.
Canada Iron Foundries, Montreal.

Castings, Aluminum:
Wentworth Mfg. Co., Limited, Hamilton, Ont.

Castings, Brass:
Wentworth Mfg. Co., Limited, Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Bronze:
Wentworth Mfg. Co., Limited, Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Gray Iron:
Canadian Steel Foundries, Ltd., Montreal, P.Q.
Electrical Fittings & Foundry, Ltd., Toronto, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
The Dominion Steel Products Co., Ltd., Brantford, Can.

Castings, Nickel Steel:
Hull Iron and Steel Foundries, Ltd., Hull, P.Q.
Canadian Steel Foundries, Ltd., Montreal, P.Q.
Algoma Steel Corp., Ltd., Sault Ste. Marie.
Dominion Steel Foundry Co., Hamilton, Ont.
Joliette Steel Co., Montreal, P.Q.

Castings, Gray Iron:
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Castings, Malleable:
Canadian Steel Foundries, Ltd., Montreal, P.Q.
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Castings, Steel:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Algoma Steel Corp., Ltd., Sault Ste. Marie.

Cement, High Temperature:
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal

Chrome:
American Refractories Co.

Chemists:
Toronto Testing Laboratory, Ltd., Toronto, Ont.
Milton Hersey Co., Ltd., Montreal.
Charles C. Kawin Co., Ltd., Toronto.

Chucks Lathe and Boring Mill:
The Dominion Steel Products Co., Ltd., Brantford, Can.

Clip and Staple Wire:
The Seneca Wire & Mfg. Co., Fostoria, Ohio, U.S.A.
United States Steel Products Co., Montreal.

Concrete Hardener and Waterproofer:
Beveridge Supply Company, Limited, Montreal

Consulting Engineers:
W. E. Moore & Co., Ltd., Pittsburg, Pa.
W. S. Tyler Co., Cleveland
Canada Furnace Co., Ltd., Port Colborne.
A. C. Leslie & Co., Ltd., Montreal, P.Q.
Steel Co. of Canada, Hamilton, Ont.

Pipe Riveted Steel:
Toronto Iron Works, Toronto, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
United States Steel Products Co., Ltd., New York.

Piston Rod Packing, Rubber & Duck:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

By reason of the high class of membership in these Companies, there are pratically no difficulties in the adjustment of losses. The manufacturer, in dealing with a stock fire insurance company, is concerned only with the enforcement of a contract, whereas with a Mutual Company, he is a member and a partner. This theory proves itself in that during a period of eighty-seven years, these Companies have never had a lawsuit over the adjustment of a loss.

Some of the companies are very active in developing new business; others are used merely for such surplus lines as the active companies cannot underwrite themselves. The Firemen's Mutual Insurance Company has been especially aggressive in the field of new business. We have felt that the policyholders are best served by making the system as large as possible, consistent with good underwriting. It is obvious that the greater the number of individual risks, the broader the base over which a loss may be distributed, with a corresponding lower cost to the policy holder.

In addition to the home office in Providence, we maintain branches in New York, Detroit and Baltimore, each with a force of engineers to furnish prompt service to members.

We make no solicitation of business whatever in Canada, our work in the Dominion being limited to the inspection of risks now insured, and the response to such applications as are made voluntarily to the home office of the Company.

PRODUCTION OF IRON AND STEEL IN JULY

A report issued lately by the Dominion Bureau of Statistics states that the production of pig iron in July presented an increase of 10 per cent. over the record for June. The output in July was 31,705 tons as compared with a production of 28,763 tons in the previous month. The decided advance in the basic pig manufactured for further use was an interesting development in this connection. In June, 14,714 tons were produced while in the next month the records indicate an output of 25,419 tons. Notwithstanding the encouraging increase over the totals for May and June, the output in July is considerably below the monthly average for 1921 and for the first half of 1922. The average for the half-year was 32,031 and during 1921 the average monthly production was 51,534 tons.

The output in July 1921 was 54,086 tons and the record for the month under review presents a decrease of 41.4 per cent. The cumulative production for the seven months ending July 31st. last was 223,892, as compared with a total production of 363,292 tons during the corresponding period of 1921.

The furnace at Hamilton was idle at the end of the month leaving in operation two furnaces at Sault Ste. Marie and one at Sydney.

The production of pig iron during July in the United States as reported by the "Iron Age" showed an absolute increase of 39,017 tons as contrasted with a loss in the daily rate of 1281 tons. The composite price increased from $24.05 per gross ton on July 25th. to $24.38 on August 1st. The Canadian price of basic pig iron as quote by one of the steel companies remained steady for July at $27.00 per ton notwithstanding the rapid increase from $24 in April to $27 in June.

Steel Ingots and Castings

A surprising advance in the production of steel was effected in July. The output in June was 32,805 tons while in the month under review 62,767 tons were produced constituting an increase of 91 per cent. The advance occurred chiefly in the open hearth basic ingots produced for further use. The output was 61,243 compared with 31,206 tons in June, comprising an increase of 96.1 per cent. The average monthly output of the grade during 1921 was 53,489 tons and the average for the first half year of 1921 was 27,938 tons. The greater part of the increase for July was reported from the steel plant at Sault Ste. Marie.

During the7 months ending with July 31st. the production of steel was 239,847 as compared with a cumulative total of 349,118 tons for the same period last year. The output of open hearth basic ingots in the seven months of the present year is below the production in the corresponding period of last year by 104,095 tons. The steel castings produced in the seven months of last year are also in excess of the production for the corresponding period of this year by 3,918 tons or 28 per cent.

The splendid increase in steel production during July in spite of coal shortage speaks well for future prospects. Improvements in marketing conditions is the chief factor accounting for the altered outlook.

STRONGER TRADES UNIONS PREDICTED

That trade unions are on the verge of a stronger and more vigorous growth than ever before in the history of the country is the conclusion of Roger Babson, statistician for Big Business. Recognizing this fact, Mr. Babson gives a word of advice to employers.

He states that government by injunction and the attempt to disrupt labor will both fail, and the inevitable result will be that the wage-earners will take a leaf from the employers' book, organize more tightly, and then probably will demand, and no doubt secure much more than if the employer uses common sense before it is too late.

Mr. Babson's article, published in his Bulletin, carries the picture of several clock faces to illustrate his points. The article is so interesting that it is reproduced in full, as follows:

"Employers the country over have been swinging the tomahawk for the past eighteen months. The days for such activity are now drawing to a close. It is time to think and reason. What we mean is indicated by the clock face. It is now about six o'clock industrial time.

"Eighteen months ago it was between 3 and 4 o' clock For the past three industrial hours we have been going along in an industrial twilight when the advantage was all with the employer and not at all with the employee.

"During the war, with the approval of some of the best minds in the nation, the practice of collective bargaining was set up in hundreds of places where previously no such thing had prevailed. Of late, following the lead of United States Steel, many firms have gone back to the individual bargain plan — some with a cast iron individual contract which binds the employee never to join a union or any other labor organization — and a systematic campaign of 'union busting' has gone into effect.

"Again, a new form of industrial government has been set up — government by injunction! The twilight employer, rather than work his way through industrial difficulties, has gone around them and has rushed to the courts to accomplish by legal force what he could not bring about by other methods"

EDITORIAL

THE USE OF ALBERTA'S COAL

It is estimated that one-sixth of the world's available coal is to be found in the province of Alberta. A large part of this is susceptible to very cheap mining, even by steam shovel. Just at present the chief trouble with Alberta's coal is that there is too much of it; it is so easily and cheaply developed that it is hardly worth the miner's trouble to put it on the cars. The population of Alberta is sparse and scattered, and the mountains, themselves well provided with coal beds, on one side and the vast extent of plain on the other prevent the shipment of fuel to distant markets that would readily take it at anything near the pit-mouth price.

These vast deposits of coal have for a generation past been the subject of vague speculation, usually projected into the centuries to come. It has been predicted that in the years to come the prairie lands will become thickly populated, and will even grow to be the centre of population for Canada. With this there will come naturally an industrial growth, based mainly upon the supply of coal.

These conjectures seem logical enough; but we should like to evolve some ideas of more immediate and more practical interest. How can the coal operators of the province of Alberta find a more extended market for their product? How can they change the present seasonal demand for coal as fuel into a demand that will keep their miners and plants busy all the year round? This problem has been faced at one time or another by almost every coal field, and in many instances the solution has been found in the establishment of a metallurgical industry, more particularly of an iron industry.

Of merchantable iron ore, Alberta has at present none discovered. This is not to say that none will be discovered as the search proceeds. But even if iron ore of the proper grade and in sufficient quantity were now available, it is a question whether an iron smelting and steel works could be worked profitably under the present conditions. This is a matter that must be left to the decision of those well versed in the commercial aspects of the case. Meantime we can look at some of the outstanding facts.

Alberta is far removed from any centre of production of iron and steel, and pays dearly for both semi-manufactured and manufactured iron products by reason of these great distances. Conversely, the expense of transporting her own products, almost exclusively agricultural, to these distant markets is so great that the profit is correspondingly small. It seems probable that, were commercial iron ore found in a suitable location in Alberta, this very fact of comparative isolation and the enhanced value of imported materials would provide a chance for successful operation. Even a small plant with a diversified production might succeed under these favourable circumstances. Once established, such a plant would create the conditions essential to its further progress, as has been demonstrated so clearly in the great and growing central industrial area of the United States. Even a small industrial population would provide a more lucrative market for agricultural products, which would induce more intensive cultivation and thicker settlement, which would again provide a better market for the smelter and mills; and so on for generations to come. The problem is how to initiate this cycle of progress.

The only iron-ore deposit of any dimensions known at present in Alberta is in the form of beds of titaniferous ore extending northward from the railway at Burmis, near Blairmore. These are, apparently, rather extensive, though their content of that bug-bear, titanium, has prevented their thorough exploration. It is possible that advances in ferrous metallurgy may bring such ore into the market, when the proximity of these deposits to first-class coal may make them of commercial significance.

Elsewhere in Alberta, the chief chances for finding iron ore would appear to be in the long strip of Palaeozoic and late pre-Cambrian rocks that compose and fringe the Rocky Mountains on their eastern side. All this area is within easy reach of good coal, through all of it is not yet within reach of a railway. It is in these early geological horizons that iron-ore deposits are most likely to be found. There has not yet been discovered in Alberta the association or iron-ore with the coal measures that has proved of such utility in Britain.

We believe that this iron-ore question, and its concomitant, the question of an iron industry, is well worth the close attention of Albertans, particularly of those Albertans interested in coal mines. The time may be ripe now for a thorough investigation, if not for the establishment of a commercial plant.

SPECIALISTS IN HIGH-GRADE STEEL

As has been pointed out more than once in these columns, if Canada is to have an indigenous iron and steel industry, it must rest principally upon some natural resource in which she excels. Only thus can international competition, which is more and more a factor in the operation of national industries, be met successfully,

Hence to gauge shrewdly the chances of the success and growth of any branch of the Canadian industry, one must examine the basis of natural resources upon which it rests, as well as the resources of human energy and initiative that will put to use what nature has provided.

At present Canada has no production of iron ore and so it goes without saying that, from the national point of view, our basic production of iron and steel is not only on an insecure foundation, but is such, in central Canada at least, that it cannot hope to compete on equal terms with our neighbours who supply us with the raw materials. It may be that the present case will be improved as time goes on by means of progress in ore-dressing and ferrous metallurgy that will make our ores of iron commercially available. We are confident this will be the outcome of progress now foreshadowed.

In the meantime, there are certain undoubted advantages possessed by our country that can be, and are being, used by some of our iron and steel men. Principal among these is cheap electric power, of growing importance with the increasing demand for high-grade and alloy steels. We are well off for some of the alloying metals, such as nickel and cobalt though we still import others. Chief among our advantages, though, is the native ability and energy of Canada's sons, without which the best of natural advantages is of little avail.

Elsewhere in this issue we print a short description of the works and products of the Hull Iron and Steel Foundries. A growing proportion of the products of this foundry is composed of the high-grade, specialized materials mentioned above, all of them made in the electric furnace and many of them subjected to special after-treatment. Not only has the best of standard practice been adopted in order to ensure superior quality, but Mr. Coplan has done a considerable amount of original research to good effect. Given correct technique, good workmanship and sound business management, progress depends upon original research and the commercial application of results thus obtained. On this basis we would judge that the Hull Iron and Steel Foundries is in a fair way to expanding, with our growing metal industry, to proportions more nearly commensurate with Canada's vast territorial extent and her promise of industrial development.

That initiative, particularly when coupled with the desire and ability to do original research, comprises a large part of the foundation upon which rests industrial success, is well illustrated in the case of Hadfields, Limited, a description of whose works is commenced in this issue. The inventive ability applied to systematic research, the sound grasp of business principles, the clear vision of the trend of the times and the determination to succeed, that have marked the progress of this world-famous concern, are all available here in Canada. We may logically hope to see a similar development of specialized steel works in Canada as the growth of our country and its industries warrant

RESULTS BY CO-OPERATION

Among the numerous interesting papers at the meeting last month in Montreal of the American Electro-chemical Society, none was more suggestive of live ideas or more fruitful of animated discussion than that of Mr. E. F. Collins on *Electric Heat: Its Generation, Propagation and Application to Industrial Processes.* After delineating briefly the scope and the means of applying electric heat industrially, Mr. Collins stressed the point that engineers skilled in the design and construction of electric heating devices have now such a firm grasp of the fundamental principle involved and of the practical requirements to be met that they can conduct their work with the utmost precision. This is a long advance from the electric furnace design and construction of even a very few years ago, when trial and error guided most of the effort, and when error followed trial much oftener than did success. The electric furnace is a comparatively new heating device, and it is highly satisfactory to know that the principles of its construction and operation have been mastered at so early a period in its career. This career is, we are confident, at present merely beginning, and will be, in Canada particularly, long and useful.

Mr. Collins' remarks on the present perfection of electric furnace design and control at once brought a rejoinder from a number of practical users of such furnaces. Their point was clearly put when it was remarked that their work in the plants required a dray horse, capable of long-continued and strenuous exertion, while they were furnished with a blood horse, sensitive, quick to learn, and capable of wonderful exhibitions, yet useless, for their purpose. This divergence between the man of science, even of applied science, working in a laboratory or under ideal conditions, and his fellow scientist in the commercial works, is typical and is a fruitful source not only of argument but of serious disagreement. Those that arranged this discussion in open meeting of the American Electrochemical Society, where good fellowship and mutual understanding are bound to prevail over the feelings that would lead to serious disagreement and misunderstanding, have employed wisely the old-age British principle of free speech and open debate.

If there is one means more prominent than any other for promoting the modern spirit of co-operation in industry, it is the periodical meetings of technical societies. Their name is legion. No industry of any consequence now lacks this evidence of cohesion. Some people think there are too many societies; perhaps there are in some spheres of life. But in the realm of scientific and industrial endeavor, these societies are primarily a means of "getting together," and the more we get together, the better it is for us, individually and collectively.

One of the potent agencies in promoting this "get together" spirit in modern industry, particularly on this continent, is the growing proportion of college-trained men in the ranks of industry. With the ranks of pure science

completely filled with men permeated with the fraternal spirit acquired in college, and with the forces of industry guided by an ever-increasing proportion of leaders trained in the same halls of learning, the old-style exclusiveness and secrecy that has hampered the progress of industry for so long is becoming rapidly a thing of the past.

Those engaged in our Canadian iron and steel industry may well take a leaf out of the book of the American Electrochemical Society. Many problems beset this industry—problems that are beyond the capacity of any single member of the industry to solve, granted the best of intentions. There is no doubt that a concerted effort would be fruitful of result, and also that the keener perception that always follows the friction of mind on mind in conference, would disclose many a new problem that is not yet obvious, as well as its solution. We have not yet in Canada sufficient cohesion among our basic iron and steel producers even to bring them together in periodical conference, either as a scientific society or as a trade association. Surely it is accident, and not design, that has left the iron and steel producers of Canada and their technical staffs without any means of discussing their common problems and voicing their united beliefs and desires.

IRON BY ELECTROLYSIS

Since the successful commercial establishment, recently, of an electrolytic iron industry at Grenoble, France, there has been a marked revival of interest in this simple and effective means of procuring pure iron from its ores. The direct production of iron, chemically pure, by means of an electric process that uses without waste almost the sum total of the energy supplied, has features that commend it not only at this time, when pure iron and its derivatives are of increasing use and value, but in this country, where there is super-abundant electric power, abundant iron ore, and a general industrial development that is merely in its infancy and that gives promise of remarkable expansion during the next few decades.

It would appear that, of all the countries where electrolytic iron might be made commercially, Canada is the most favoured of nature. In both the east and the west, hydro-electric power can be developed in colossal amounts at a cost that allows of its application to electro-metallurgical processes. In both the east and the west, most of the power thus available is remote from large agricultural areas and general industrial communities whose competition for the power might raise its price. It is probable that the use of this power will depend largely upon the development of electro-chemical and electro-metallurgical industries.

Though Canada is, so far as is known at present, poor in iron ore suitable for direct use in the blast-furnace, she has an abundance, both in the east and the west of other ores of iron, both sulphide and oxide. The present attempt at Trail, British Columbia, to make use of the pyrrhotite gangue from the huge ore deposits of the Sullivan mine illustrates the direction in which an indigenous Canadian iron industry may be developed. If the metallurgists at Trail should succeed in separating economically the iron and sulphur from the Sullivan ore, as already they have done the silver, zinc and lead, British Columbia's long-desired iron and steel industry may become established without more ado.

We print to-day an account by Mr. Axel Estelle of two processes for the production of electrolytic iron, with by-products, that he has worked out recently. The practical details that elucidate and amplify his chemical equations show that his processes are based, not merely upon ideas transferred to paper, but upon practical experimenting. A considerable part of the data he gives and the conclusions he draws is common to other similar processes; but he has new data and new conclusions that make his paper worthy of close study.

The possibility of producing iron from its compounds with sulphur seems rather remote, to those of us accustomed to rely upon the blast-furnace with its cheap raw materials and its unrivalled economy of operation. Many an attempt has been made to use pyrrhotite or pyrite as an ore of iron by means of putting the sulphur into saleable form, generally in the form of sulphuric acid. In Canada, this use of the iron sulphides has been unprofitable because of the limited market for sulphuric acid. If, however, the sulphur could be recovered in its native form, a new field would be opened which would bear close examination. The Estelle process for sulphide ores of iron proposes the recovery of pure iron and sulphur, with any precious or semi-precious metals concentrated in a small residue.

Ordinarily we consider the oxygen of oxide ores of iron as something merely to be got rid of at the least possible expense. The Estelle process proposes to catch and use this oxygen after it has been separated from the metal. The use of oxygen in modern industry is increasing very rapidly. It is possible that here lies an opportunity for producers of oxygen to manufacture the gas in a way that will aid materially in promoting our production of iron from Canadian ores. The magnetic concentrate from our low-grade ores would be especially suitable for this purpose.

EDITORIAL NOTES

From October 25th to November 8th, there will be held in Honolulu, Hawaii, a conference called by the Pan-Pacific Union to discuss international questions of finance and commerce that affect the countries bordering on the Pacific. It is expected that all these countries will send delegates, many of them official representatives of the various governments, while others will represent boards of trade and financial organizations. At the request of Japan, a number of leading educationists have been invited to attend. Canada will be represented by a delegate from the Department of Trade and Commerce. It is encouraging to find this evidence of international amity and the desire to co-operate in this war-wracked world.

A Modern Alloy Steel Foundry

HULL IRON AND STEEL FOUNDRIES, LIMITED

The present-day iron and steel metallurgy of Canada is characterised to a growing extent by commercial establishments peculiarly suited to Canadian conditions. One of our chief assets in building up an indigenons iron and steel industry in Central Canada is, and will continue to be, the availability of cheap electric energy in large quantities. Therefore an iron and steel plant whose operation is based primarily upon this natural resource is likely to endure and prosper. Such an one is the Hull Iron and Steel Foundries, Limited, at Hull, Quebec. This plant has an extensive site beside Hull West station on the Canadian Pacific Railway. It is of thoroughly modern construction and design, and may well serve as an example of the steel foundries that are bound to be built up at various strategic points throughout Canada. Indeed, this movement is already well under way, and will keep on so long as the higher grade of product furnished by a steel foundry, and particularly by an alloy steel foundry, continues to be in growing demand.

Products of the Foundry

The products of the Hull Iron and Steel Foundries are principally plain steel and alloy steel castings for railway and mining use. There are made complete locomotive sets, including frames up to 36 feet in length; car castings and general railway castings; manganese steel guard rails; machine moulded steel gears, up 15 feet in diameter; manganese steel liners and forged balls for ball mills; gyratory crusher heads and liners and crusher jaws of manganese steel; and alloy steel stamp shoes and dies. Besides these there is a rapidly increasing production of a special steel grate bar, which will be described in detail below.

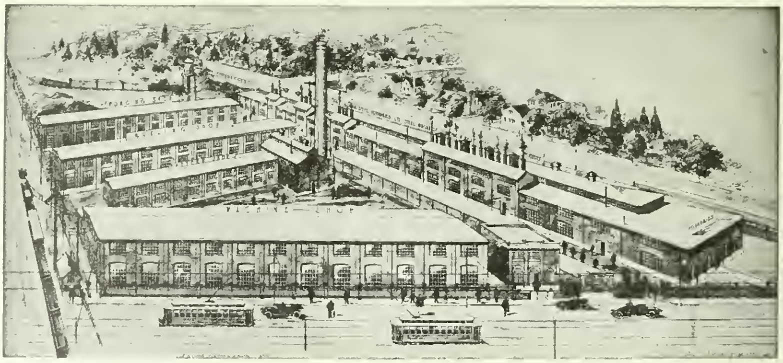
Most of the output of castings consists of plain carbon steel, as is required by the trade. But a growing proportion is of the more durable, though more expensive, alloy steels. Chief among these latter is manganese steel, which has become invaluable for use in crushing machinery and in certain parts of railway equipment since its historic discovery by Sir Robert Hadfield. Chrome-nickel, chrome-vanadium and any other alloy steels are produced as required, but their use is very limited at present. Most of the alloy steel products are subjected to heat treatment to derive the full benefit of their content of the rarer metals.

Heat-Resisting Grate Bars

Mr. Coplan, president and general manager of the Hull Iron and Steel Foundries, has a full measure of that inquiring disposition that leads to research and experiment and thereby to progress and prosperity. After two years of experimental work, he produced a grate bar of heat-resisting alloy steel especjally suited to withstand the exacting conditions of the locomotive fire-box. The sample sets of bars originally installed have now been continously in use for 2½ years, are still as good as new and will apparently last indefinitely.

The chemical composition of this useful alloy has been patented in the United States and Canada. The grate bars have been adopted under the regulations of the United States Railways, and an export trade has already been commenced. The steel grate bars are 25 to 40 per cent. lighter than cast-iron bars, and consequently their first cost is only slightly higher. They are, of course, useful in stationary boilers, especially where standard shapes and sizes are required; but where only a small number of a special design are required, the cost of the requisite patterns is a serious consideration.

The present capacity of the plant is 600 tons of castings a month. This is to be increased shortly to 1,000 tons a month.



General View of Plant —Hull Iron and Steel Foundries.

Main Foundry Building

The main building, containing all the principal facilities of the foundry, is 680 feet long and 100 feet wide, of three-bay design. The central part, 50 feet wide, is used for moulding and casting. Across one end are the facilities for making cores. Ranged along the two side bays, each 25 feet wide, are the various other items of foundry equipment, so arranged that material moves always in one direction down the long building.

The core-making department is served by six small jib cranes of four tons capacity. The main bay has two 50-ton and one 40-ton electric travelling cranes, running its whole length. A railway siding enters the delivery end of the building, and another siding, outside, brings raw materials along the side on which the melting and refining furnaces are placed. The side bay next this siding can fairly be called the melting and forging bay, and that on the other side, the finishing bay, the central bay being used principally for casting.

Melting and Forging Bay

Along this bay there are ranged in succession core ovens and drying ovens for moulds; a small cupola and two Tropenas converters; a Héroult electric furnace; an annealing oven for castings; a re-heating oven; two small forges; and welding apparatus. A number of these items of equipment deserve more detailed description.

The cupola and Tropenas converters are not at present in use, having given place to the adjoining electric furnace. Their capacity is $1\frac{1}{2}$ tons per heat, and each can handle 10 heats in 24 hours.

The annealing oven is oil-fired, and will take a casting up to 40 feet in length. As locomotive frames up to 36 feet in length have been made in the foundry, this capacity is required. The re-heating oven, next the forges, is 4 feet by 12 feet, and is also oil-fired.

The Héroult electric furnace is of the standard three-phase type, with a capacity of 25 tons in 24 hours. It produces 6 to 7 tons per heat. It is basic lined, is fitted with 6-inch graphite electrodes, and uses a maximum current of 1850 horse-power at 110 volts. The raw material used is principally a good grade of heavy melting scrap. The basic hearth allows of a very complete removal of phosphorus from the charge under an oxidising slag, which is removed. A new reducing or "carbide" slag is then built up, which removes sulphur and oxides from the bath of steel, as well as providing a cover under which the ferro-alloys required can be added with great precision. It is the use of this reducing slag for finishing the steel that makes the basic electric furnace so eminently useful in producing the highest grade of steel products. In skilful hands, it will give steel equal to the best made by the crucible process, at a fraction of the cost. Due to is strong refining action first under oxidising and then under reducing conditions, all the impurities that commonly bother the steel maker can be effectively removed, even when the melting stock is far from pure.

The additional Héroult electric furnace it is intended to install shortly will be smaller, of three tons capacity.

The forges are used principally to make the well-known Hisco balls for ball mills. They are of 900-pound and 1500-pound size, respectively. The steel billets for the balls, as cast, are lozenge-shaped. In the forges they are hammered into spheres, thereby acquiring the toughness characteristic of forged products.

For welding, both oxy-acetylene and electric apparatus are available as required. It is not generally realized that no single welding equipment is suitable for all and sundry purposes; hence the necessity for having available more than one means for both fabricating and reclaiming materials by welding.

Finishing Bay

In the finishing bay there are an enclosed sand-blast with respirators for workmen; an assortment of swinging and stationary grinders; and a heat-treatment furnace for manganese steel. This bay provides also ample storage for moulds.

The furnace for heat-treatment is oil-fired, 6 feet by 8 feet inside dimensions. It is equipped with a pyrometer for precise heat control, this same pyrometer having a thermo-couple in the annealing oven as well to which it can be switched. The wonderful qualities of the Hadfield manganese steel are brought out simply by quenching from a prescribed temperature, which appears as a bright red heat. The high content of manganese imparts to the alloy its characteristic toughness only after this quenching, which is effected in a tank of running water directly in front of the furnace, into which the red-hot castings are dropped from the furnace door.

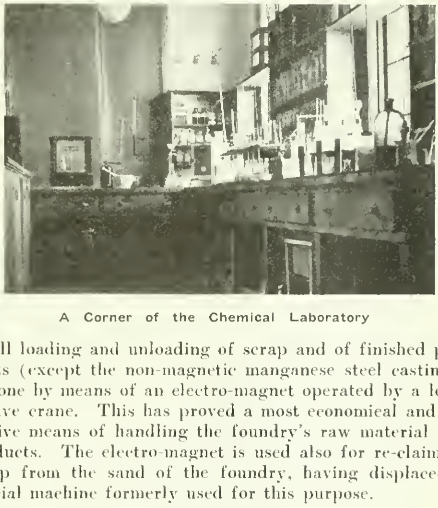
Accessory Equipment

The foundry is well served with the accessories required by modern practice. There is a well-equipped machine shop including a 15-foot boring mill (used for finishing large gears), a large radial arm drill, and the ordinary machine shop tools. Apart from the large boring mill, the shop is used exclusively for the internal repair work and construction of the foundry.

The adjoining compressor room contains a vertical, high-speed, direct-connected air compressor to provide air for rammers, oil-fired furnaces, etc. There are three small belt-driven compressors used as auxiliaries and spares. In the same building is a motor-generator set to provide direct current for welding.

The electric current used in such large quantity in the plant is brought from the Chaudière Falls generating plant, close by, at 11,000 volts, and is stepped down in a sub-station at the plant to 220 and 110 volts.

There is a separate commodious building for pattern storage, well separated from the rest of the plant on account of the risk of fire. Another building provides ample storage room for stock of the various sorts required.



A Corner of the Chemical Laboratory

All loading and unloading of scrap and of finished products (except the non-magnetic manganese steel castings) is done by means of an electro-magnet operated by a locomotive crane. This has proved a most economical and effective means of handling the foundry's raw material and products. The electro-magnet is used also for re-claiming scrap from the sand of the foundry, having displaced a special machine formerly used for this purpose.

Offices and Laboratory

A notable feature of the foundry is the attention paid to its administrative equipment. The office building is commodious and well-equipped, and its appearance is outstanding in both Hull and the adjoining Capital City. Well-planned garages are available for those who use cars.

The top storey of the office building contains the laboratory, which is fitted out to fill the needs of the foundry. Every heat of steel is analysed. A competent analyst is employed and every advantage is taken of the art of the modern metallurgical chemist — an art that, though so highly essential to the success of a modern foundry, is occult to and shunned by so many foundry managers even in these enlightened days.

Though every facility is provided for the control and direction of the operation of the foundry by means of the chemist's art, its products are sold on a basis of practical

performance. Of course castings and forgings are made to standard analysis, or to special analysis if required. This is in complete accord with modern practice. As yet we know too little of the constitution of metals, and more particularly of alloy steels, to allow us to predict physical performance on the basis of even the most accurate and detailed chemical analysis. The analyst is an essential factor in a well-ordered foundry; but the quality of the product is still dependent mainly upon the foundryman's practical skill.

First-Aid Building

A striking example of the care and thoroughness with which this foundry has been planned and is operated is its first-aid building. This is a separate structure, close to the entrance to the works and next the time-keeper's office. It is fully and expensively equipped with all the necessary appliances and supplies, and is served by an attendant trained by the St. John's Ambulance Corps.

Mr. A. H. Coplan is president and general manager of the Hull Iron and Steel Foundries. Mr. F. H. Cross is assistant manager. Mr. Coplan is to be congratulated heartily for his success in building up a unit in our indigenous iron and steel industry that is a credit to Canada and points the way to further development.

STEEL COLUMN HOOK

The modern factory and warehouse, being largely built of steel, has no necessity for the heavy wooden posts formerly used to support the floor or roof above. These have passed away and given place to the steel column of much smaller dimensions. Many who were acquainted with the old style will remember how frequently those thick posts were used for various purposes—from hanging up a workman's coat to racking

long bars by supporting them on spikes driven into the wood. However, any one who misses this feature in the steel-constructed building can utilise steel columns in the same way with very little trouble. In the accompanying photo a hook arrangement is shown that has proved very serviceable in this connection.

The column illustratd is three-inch. The hook is made by bending a piece of round bar-iron the required shape, splitting the end and spreading it to form a Vee. A short distance from the Vee a hole is drilled, of a diameter equal to twice the thickness of the wire, which is coiled a couple of times around the column. When assembling the device, both ends of the coiled wire are pushed through the holes in the hook and securely twisted around.

In operation, the hook swings downward when a weight is placed upon it and so tightens the wire coils on the column. A little study of the photo will serve to explain the principle involved. It will be seen also that the hook can be slid up and down the column and automatically tightened in any desired position when a weight is placed upon it.—Harry Moore.

A COURSE IN INDUSTRIAL METALLOGRAPHY

at McGill University an extension course in Metallography will be given as in previous years, by Messrs. Harold. J. Roast F. C. S., F. C. I. C., and Charles F. Pascoe F. C. I. C. The student need have no previous knowledge of the subject.

University, commencing on Monday November the sixth
The course consists of fifteen periods, held on Monday nights at the Chemistry and Mining building McGill
Under the auspices of the department of Metallurgy at 8 P. M.

Application should be made to either of the lecturers, their address being McGill University, department of Metallurgy.

The fee for the course is $20.00 payable to the Bursar.

In as much as only twelve members can be accomodated at one time students will be enrolled in order of their applications.

In past years the class has been composed of mechanics, engineers, chemists, and those desiring a winter hobby, or whose business brings them in contact with metals and who desire to have more knowledge of their composition. NO PREVIOUS KNOWLEDGE IS ASSUMED and the course is essentially practical from first to last.

If any students from a previous year desire to continue their work provision will be made for an advanced course if sufficient members are obtained.

Ferrous and non-ferrous metals are dealt with equally, training being given in preparing them for examination under the microscope and finally photographing the various structures developed.

PROFESSIONAL ENGINEERS OF ONTARIO

The organization for Registration of Professional Engineers under the Act passed at the last session of the Legislature, has been completed, and today the Association has opened a permanent office at 96 King St. West, Toronto. Brigd. Gen. C. H. Mitchell is President, and Mr. Robert A. Bryce, Vice-Pres. of the Provincial Council, which comprises representatives of each of the five branches Civil, Mechanical, Electrical, Chemical and Mining. Mr. R. B. Wolsey has been appointed Registrar and Secretary Treasurer.

The Story of Hadfields, Limited

SECTION 1 — THE DEVELOPMENT OF ALLOY STEELS

EARLY HISTORY

The production of carbon steel on a tonnage basis is the result of outstanding metallurgical inventions in the nineteenth century. The influence of the work of Bessmer, Siemens and others is still potent in the iron and steel industry throughout the world. But fundamental and necessary as cheap carbon steel has come to be, modern engineering for many purposes demands steel of much higher qualities, including greater elasticity, tensile strength and resistance to wear. Consequently there has grown up, mainly since the dawn of the twentieth century, but with beginnings going back to the latter part of the ninteenth, a great new branch of the steel industry devoted to the manufacture of special steels of various kinds. Without these steels the motorcar, the airplane, the locomotive, and many other necessities of modern life, could not exist as we know them. Because we have lived in the midst of this transition and development, it is difficult to grasp at once the far-reaching effect that the application of modern special steels has had on engineering affairs. In the development of this branch of the industry, British metallurgists and steelmakers have always been prominent.

MANGANESE STEEL

Until the modern alloy steel known as Manganese Steel was discovered by Sir Robert Hadfield in 1882, practically nothing or very little had been done with regard to what is now one of the most important industrial advances in metallurgy, that is alloy steels. In addition to placing at the disposal of engineers a new metal of exceptional value, this discovery had indirect results of an important character, first of all, in the impetus given to metallurgical researches in a new field, and secondly, in promoting more intimate relations between experts of different nations, and especially with America. It was, in fact, in America that manganese steel first received its encouragement on a large scale. Time after time, Sir Robert has received at the hands of Americans recognition of his eminent services in the metallurgical field, and his numerous visits to that country doubtless account largely for his cosmopolitan outlook on international affairs, and in particular, his enthusiasm for Anglo-Saxon co-operation, not only in metallurgy and industry, but in international politics.

Value Of Hadfield Researches

The Hadfield discovery opened up a new era in metallurgical research and led to the development of quite a number of new alloys, the results of which have brought highclass steels into very general use. The Hadfield manganese steel is now known under the trade mark term "Era."

The steel may be said to have developed a literature of its own, Sir Robert having contributed 19 papers on this subject among his addresses, papers, articles and brochures, some 135 in number, on various metallurgical topics. These now form an important part of the library section of the Hadfield Research Department. The stimulus to new research has frequently been recognised and metallurgists in several countries have acknowledged the help they have received from Sir Robert Hadfield in the readiness with which information has been furnished and samples supplied, the latter now amounting to thousands, despatched to all parts of the world.

Opinion Of Scientists

With regard to the great importance of the Hadfield discovery and invention of managanese steel, the following statements have been made by various prominent scientists during discussions that have taken place on the Hadfield papers before scientific and technical societies.

Great Britain:—As regards Great Britain, in 1888 Dr J. E. Stead, F. R. S., Bessemer Gold Medallist, and President of the Iron and Steel Institute 1920-1922, and one of the great leaders of metallurgical thought, said: "Hadfield had surprised the whole metallurgical world with the results obtained. The material produced was one of the most marvellous ever brought before the public."

In the same year, 1888, Sir W. C. Roberts-Austen, F. R. S., a past-President of the Iron and Steel Institute, one of the leaders of his day in this branch of science, said: "Hadfield had introduced a most remarkable series of materials and was entitled to the gratitude of all metallurgists and engineers."

In February 1922, Sir Henry Fowler, K. B. E., Chief Mechanical Engineer of the Midland railway, in his address to the graduates of the Institution of Mechanical Engineers, stated: "It is not quite forty years since Sir Robert Hadfield, one of our Vice-Presidents, brought out two steels which have done much to change certain work with which our profession is associated. His work on managanese steel really opened up a fresh era and was, with the exception of Mushet's work, the first investigation into alloy steel. This steel is used wherever heavy wear and tear has to be encountered, and its non-magnetic qualities are of great advantage under certain conditions.

"Following this, Sir Robert brought out an alloy of iron and silicon called Low Hysteresis Steel, which, owing to its being more magnetic than iron itself under low magnetic forces, is particularly suitable for use in the manufacture of transformers, etc.

"This alloy steel work of Hadfield has been followed up enthusiastically by matallurgists, and it is in no sense an exaggeration to say that the motor car and the aeroplane, as we have them today, are the result of this work of Hadfield's."

Professor H Appleton, M A, Public Orator at the University of Sheffield, on the occasion of the conferment upon Hadfield of the monorary degree of Doctor of Metallurgy in 1911, said:

"Hadfield's discovery of Manganese Steel not only *revolutionised the whole trend of metallurgical thought*, but proved to be of extraordinary and world-wide utility. By the extent and variety of his research work in other directions he has *added enormously to the scientific knowledge of iron and steel and their alloys*. As an investigator his work has received universal recognition."

Professor J. Goodman, M. Inst. C. E., Public Orator at the University of Leeds, on the occasion of the con-

ferment upon Sir Robert Hadfield of Honorary Degree of Doctor of Science in 1912, said:

"*By his far-reaching discovery of manganese steel,* Hadfield has revolutionised certain branches of engineering. By his investigations he has thrown much light on the influence of low temperature upon steel and also on segregation in steel ingots. He has also taken an active interest in the development of scientific and technological education."

America:—With regard to America, the late and much esteemed American metallurgist, Professor H. M. Howe, in his great work "Iron, Steel and other Alloys", published in 1903, when speaking of managanese steel, said: "This steel has a combination of properties which, so far as I know, was not possessed by any other known substance when this remarkable alloy, known as manganese steel, was discovered by Hadfield. His further and extremely important papers on manganese steel have much increased our knowledge of this remarkable substance."

Professor Bradley Stoughton, the well-known American metallurgist, in his work, "The Metallurgy of Iron and Steel", published in 1911, says: "*We owe the discovery of manganese steel to the untiring ingenuity of Hadfield*, and its story will be an inspiration to every inventor. It resulted in a material whose combination of great hardness and great durability was hitherto unknown and might readily have been believed to be impossible. Constant study and perseverance must have been the qualities that led to this revolutionary invention."

France: As regards France, the late Professor F. Osmond, Bessemer Gold Medallist of the Iron and Steel Institute, and the leading Metallurgist in France, made the important announcement in 1888 that: "Hadfield's discovery and invention of manganese steel was not only the discovery of a new alloy, curious, of great scientific value, and yet useful, but in the history of the metallurgy of iron it ranked as a discovery equal in importance to that of the effect of quenching carbon steel, and was the *only one of the same order which it had been reserved for our age to make.*"

In the same year, 1888, Monsieur A. Pourcel, the eminent French metallurgist, who received in 1909 the Bessemer Gold Medal of the Iron and Steel Institute, stated: "I consider the production of manganese steel the most important event in practical metallurgy during the last ten years, and which might take its place beside the result of the labours of Gilchrist, Bessemer, Siemens, Martin and Mushet."

Monsieur T. Gautier, the eminent French scientist in a letter to Sir Robert Hadfield in September 1884, stated:

"I thank you very much for your beautiful samples of maganese steel. After carefully examining and inspecting the fractures and the other tests, I feel bound to state that the *Manganese Steel is an entirely new kind of steel and is a new invention.* Such a steel has never previously been manufactured."

Germany:—In Germany, Mr. G. Mars, the eminent writer on metallurgy, in his book "Die Specialstahle", published in 1912, stated: "The most extensive experimental researches, which may be said to have laid the foundation for our entire knowledge of steel alloys, were carried out by Hadfield in the eighties of the last century.

"His two works on Manganese Steel and Silicon Steels have become of decisive importance as regards the development of the technics of steel alloys. They not only supplied a wealth of important facts from the purely scientific point of view, but they subsequently led up to the evolution of many new qualities of steel.

"The exceedingly thorough investigation of manganese steel has been carried out by Hadfield in a manner which must be held exemplary for all time."

The foregoing opinions of scientific men in different countries are quoted in order to show that the invention of manganese steel by Hadfield has been recognised internationally. Similar opinions have been expressed by Belgian, Swedish, Italian, Russian and other metallurgists.

Whilst it is difficult to estimate the immense saving effected throughout the world by the use of the Hadfield manganese steel, it may be mentioned that a grand total of at least one and a half million tons has been produced. The saving effected by the use of this material in increased durability, greater toughness, thus avoiding accidents by breakage, also other qualities, represents a total sum which cannot be far short of thirty million pounds sterling.

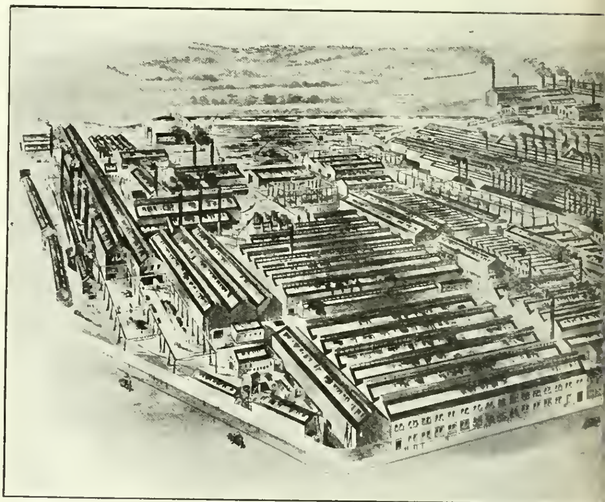


Fig. 1. — Bird's eye View of Hadfields

Applications of Manganese Steel

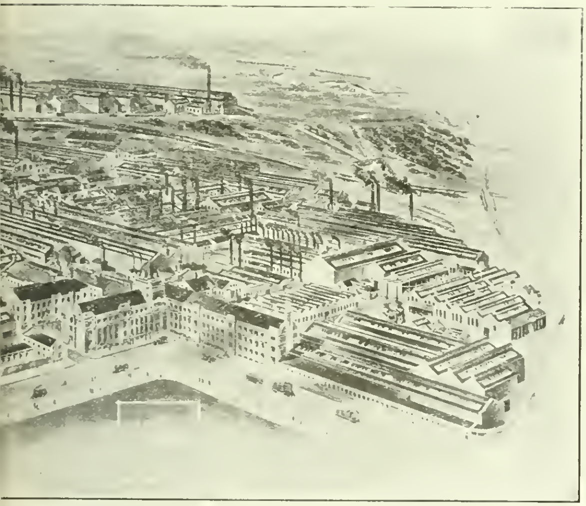
The importance of Manganese Steel as a metal of great toughness and durability is best demonstrated by the numerous uses to which it is applied. It was the practical outcome of certain newly discovered properties of iron and manganese, some of which apparently, were not even suspected. Metal having a composition suggesting inevitable brittleness proved to be extremely tough, and although the alloy contains from 88 to 90% of iron in its composition, one of its great merits is its non-magnetic character even at a temperature of -269° Cent., closely approaching the absolute zero. In its forged condition and after heat treatment it possesses the high tenacity of 60 to 70 tons per square inch, and elongates no less than 50 to 60%.

Track Work:—The use of the Hadfield manganese steel for peace purposes has been largely in connection with tramway points and crossings, now widely adopted throughout England and numerous foreign countries,

while it seems very likely that rails made of the material will be increasingly used at leading railway centres. A notable example of this use is at the Central Station, Newsastle-on-Tyne. At the Fitzalan Square Junction, Sheffield, the largest and most important Tramway Junction in the city, is constructed entirely of Hadfields "Era" (Trade Mark) Manganese Steel. This lay-out was put to work in September 1907, and relaid in May 1919, after twelve years service, during which time 13,500,000 cars have passed over it.

The first junction lay-out in Hadfields "Era" manganese steel supplied for Fitzalan Square, was in 1901. Its condition was carefully recorded up to the date of removal in September 1907, when it was replaced, not because it was worn out, as it was admittedly fit for several years further service, but because the Junction had to be re-designed so as to provide for the additional tracks, needed to meet the demands of the greatly increased car service.

The following data respecting the two lay-outs demonstrate the supreme wearing qualities of this most valuable "Era manganese steel:—



, Hecla Works, Hadfields

	1st Lay-out Laid Sept. 1901 Replaced, Sept 1907	2nd Lay-out Laid Sept. 1907 Replaced, May 1919
Average number of cars per day.	2,700	3,510
Tonnage per day	27,000	30,000
Maximum vertical tread wear per 10,000	.0021 in.	.0028 in.
Total vertical tread in six years	.484 in.	.781 in.
Total number of cars that passed over the Junction	5,225,000	13,500,000
Number of points	8	16
Number of crossings	18	28
Number of intersections	28	40
Number of rails .	47	59
Number of year's wear	6	12
Total weight of lay-out	20 tons	33 tons

The same lay-out in ordinary carbon steel commenced to wear out in a few months, and at the outside had a life of only eighteen months to two years.

Dredger Work:—A great deal of use of the "Era" (Trade Mark) manganese steel is made also in dredgers, where hardness, toughness, and resistance to erosion are necessarily of great value.

LOW HYSTERESIS STEEL

Another of the inventions that has emanated from the Hadfield works has been that relating to Low Hysteresis Steel. Practically all transformers and much other electrical apparatus are now made of this material

This low hysteresis steel has the valuable property of improving rather than ageing in service. The effect of age upon the old transformers involved considerable losses of energy, and investigations have shown that in many cases this has amounted to 15% and even 20%, involving a waste of one-sixth of the coal employed. The total saving to the world since the introduction of this material has probably been not far short of fifty million tons of coal.

It may be interesting to add with regard to the Hadfield invention of low hysteresis steel that Dr T. D. Yensen, of the Westinghouse Electric Company's research laboratory, a prominent American scientist, in his paper in 1921 to the Electrical Journal on the "Development of Magnetic Materials" stated: "The total saving already effected to the world by the Hadfield low hysteresis material in reducing energy losses, saving in copper, better apparatus and other advantages, amounts to no less than 340 millions dollars [about eighty million pounds sterling]—nearly enough to build the Panama Canal.

Professor Morton G. Lloyd, one of the leading American electrical experts, in his paper on "Magnetic Hysteresis", read in July 1910, stated:

"Sir Robert Hadfield, in England, has experimented with a number of alloy steels, and found that either aluminium or silicon would greatly improve the magnetic quality, when introduced in a proportion of two or three %. Silicon has proved the most useful industrially. Barly in 1903 Hadfield applied for and was granted a patent covering the use of this ingredient to the extent of a quarter of one per cent to five per cent. Later patents issued to him also cover the admixture of aluminium and manganese, as well as special processes of annealing aimed to secure the best characteristics for electrical use. This low hysteresis steel is that now almost entirely used today for transformer cores, and is made by several of the Hadfield licenses in this country [U.S.A.] The proportion of silicon varies according to the purposes required. The specific conductivity of the material is about one-fourth that of ordinary annealed steel, and the eddy current loss is reduced in the same proportion. The hysteresis loss is about two-thirds to three-fourths the value in ordinary transformer steel, which is another substantial gain. Furthermore, the ageing in the Hadfield steel is negligible. By ageing is meant the increase in core losses which occurs with time.

"Experiments were also made as regards utilising the low hysteresis steel in the cores of generators and motors, but not with entire satisfaction. This material has high permeability in weak fields, making it specially suitable for series transformers. Its permeability falls off at high magnetisations.

"No other alloy steel has proved of such industrial importance as the Hadfield low hysteresis steel."

The late Lord Kelvin, F. R. S., made the following remarks in 1902 with regard to Sir Robert Hadfield's paper "Electrical Conductivity and Magnetic Properties of Different Alloys of Iron":—

"The amount of labour devoted to this exceedingly important investigation must strike everyone present this evening; the results speak for themselves. The enormous increase in the permeability of iron obtained in and by the Hadfield alloys and treatment is certainly a magnificent result."

NICKEL CHROMIUM STEEL

The quality and strength of nickel-chromium steel, has been developed at the Hadfield works in a remarkable degree, as exemplified in the wonderful performance of the armour-piercing projectiles up to 18" calibre manufactured by Messrs. Hadfields. These are capable of penetrating the thickest armour afloat, a test which is probably the most severe to which steel can be subjected. In the continuous contest between armour and projectile, the victory has rested now with one side, now with the other. It may be said that at least for a period, modern hard-faced armour was capable of resisting the penetration of projectiles, at least under the practical condition of long-range engagements. The projectiles developed by the Hadfield Company are however, capable of passing undamaged through the strongest naval defence, including the very severe test of impact at considerable angles of obliquity. The capacity of output during the war of these armour-piercing projectiles at the Hadfield works was on an enormous scale, nearly one thousand per week,—that is of large armour-piercing projectiles, 12-inch calibre and upwards. There was therefore, never any danger of the British fleet running short of ammunition of this type.

SECTION II

DEVELOPMENT OF HADFIELDS

The late Mr. Robert Hadfield founded the Firm of Hadfield Steel Foundry, limited, which became finally Hadfields, Ltd., of the East Hecla Works and Hecla Works, Tinsley and Attercliffe, Sheffield.

Mr Hadfield was greatly respected, not only in this native city, but in iron and steel circles at home, in America, and on the Continent. Before starting the new steel castings industry in Sheffield, he had a long and wide experience as a steel maker at the Attercliffe Steel Works, Sheffield, which he originated in 1869. Large quantities of crucible steel, tool steel, steel wire, and cold rolled strips were produced there. It may be of interest to add that the greater portion of the steel strips used in connection with crinolines, so fashionable at one time, were produced there.

Mr. Robert Hadfield was the first to introduce into Sheffield the manufacture of stell castings on a general and large scale at the Hecla Works. These eventually developed into the present very large business of steel castings and forgings, tramway track work, crushing machinery, and many other branches, at the East Hecla Works, Sheffield, comprising the largest individual steel casting foundry in the world.

The Chairman of Messrs. Hadfields Ltd., Sir Robert Hadfield, was educated at the Sheffield Collegiate School, which was under University management, and as regards the modern side was modelled on the lines of Cheltenham College and Kings College, London, special attention being paid to chemistry and physics. He obtained four or five prizes and three scholarships for Natural Science and other subjects. He commenced business in 1875 entering his father's works the following year. Six years later he discovered and invented manganese steel and later, low hysteresis steel. Since 1888 he has been chairman of Hadfields Ltd. The Hadfield concern had the distinction of leading the way in 1891 in the introduction of the 48-hour week.

Honours since conferred upon Sir Robert have been remarkably numerous. In 1896 he was made Justice of the Peace for Sheffield. Three years later he became Master Cutler of the same city. He was President of the Iron and Steel Institute for two years in 1905-07. From this Institute he received the Bessemer Gold Medal in 1904. He was created Knight in 1908, and elected Fellow of the Royal Society 1909. The Degree of the Faculty of Metallurgy for the University of Sheffield was conferred upon him in 1911, the honorary degree of Doctor of Science for the University of Leeds in 1912. He held the presidency of the Faraday Society from 1914 to 1920, was made a Freeman of the City of London in 1917, and in the same year was created a Baronet.

Special mention should be made of the conferment by American engineers of the John Fritz Gold Medal in 1921, a special deputation of distinguished Americans visiting this country to hand the medal to Sir Robert. The only British recipients previously have been Lord Kelvin and Sir William White.

As already suggested, Sir Robert Hadfield is a great enthusiast for Anglo-Saxon co-operation, and he took the opportunity, when the John Fritz Medal was presented, to interpret this honour as a mark of appreciation not only of himself, but of the work of British engineers during the war, as thus expressed by the engineers of the United States. Sir Robert is about as well known in America as he is in Great Britain, and the has great ideas as to future possibilities in the way of scientific and other co-operation between the various branches of the English-speaking race. On the occasion of the presentation he suggested the establishment of a great Engineering Council for Anglo-Saxons throughout the world, an idea that appears likely to bear fruit.

Sir Robert Hadfield may be described as the Dean of the special steel industry, a position that has been recognised both in his own country and abroad.

Amongst other awards and premiums he has received eight gold medals and two bronze medals from scientific and technical institutions in Great Britain, America and France. In addition he has held a large number of fellowships, presidencies, vice-presidencies, honorary and other memberships of leading technical and scientific societies.

Sir Robert Hadfield, although a native of the great steel-making city of Sheffield where he was born on November 29th, 1859, comes from the Derbyshire family of that name who lived at the quaint village of Edale, right in the centre of the Peak districts. This quaint Derbyshire village has its little church and churchyard where many of the yeoman Hadfields lie buried, surrounded by the Kinderscout Hills, almost mountains, from 1,800 to 2,000 feet in height. This in the district described both by Mrs. Humphrey Ward in "David Greive" and Charlotte Bronte in her novel "Jane Eyre."

Edale is not far from historic Castleton, celebrated by Sir Walter Scott in his "Peveril of the Peak", with its Mam Tor, Win Hill, the Shivering Mountain, the famous Blue John Mine, and other places of fascinating historic interest. Chatworth, Haddon Hall, and Rowsley are all within hailing distance, and through these Derbyshire vales flows the well known River Derwent of Isaac Walton fame.

Going as far back as the Field of Flodden, 1615, there was a Major Hadfield fought there, and his sword is in the possession of Mrs. Hadfield Bennett, grand-daughter of the late Mr. George Hadfield.

Mr. Samuel Hadfield was twice Master Cutler of Sheffield, first in 1828 and then in 1837.

One branch of the family was represented by the late Mr. George Hadfield, one of Sheffield's Members of Parliament for the long period of 25 years.

Another branch of the family, on the Brown side, has been represented by the late Sir John Brown, second cousin of Sir Robert Hadfield, who did so much for Sheffield industrially and by this local beneficence. He was in his time both Mayor and Master Cutler of Sheffield, in fact one of the chief builders of Sheffield's industry between the years of 1850 and 1870. He has often described how in the early days he took long journeys and business trips by coach and carriage, at the time when there was no railway to Sheffield.

Sir Robert's father (Mr.Robert Hadfield) was for fourteen years on the City Council of Sheffield, and chairman of the Highways Committee for many years. He and his wife were highly respected and much beloved in the district.

One of the Robert Hadfields went to Canada where he married Miss Appleby, the sister of the father-in-law of Sir Charles Hanson, one of the recent Lord Mayors of London. Miss Hadfield, daughter of Mr. Robert Hadfield, married Mr. Douglas Cornell of Buffalo (N. Y.)

THE EFFORTS OF THE HADFIELD DIRECTORS

Through Sir Robert Hadfield's efforts, and those of his associates, Mr. A. M. Jack, M. Inst. C. E., formerly Managing Director and now retired; Mr. P. B. Brown, M. Inst. C. E. and Major A. B. H. Clerke, C. B. E., late R. A., the present Managing Directors, also other Directors and assistants, there has been built up at Sheffield the great establishment of Messrs. Hadfields Ltd., one of the most widely known steel-making organisations in the world and one particularly prominent in the special steel field. Hadfields do not, of course, confine their efforts to manganese steel or low hysteresis steel, but include in their output a great variety of steels for many purposes both as steel castings, forgings and rolled material.

Mr. A. M. Jack, C. B. E., M. Inst. C. E., formerly Works Manager, then successively Director, Managing Director, and finally Deputy Chairman, who has lately retired after a faithful service of 33 years, rendered great assistance in the development of the firm from comparatively small beginnings to its present large scale, when the works comprise some 51 acres of buildings and 214 acres of land.

Mr. P. B. Brown, M. Inst. C. E. has been with the firm since 1888, working his way from the drawing office, Works Manager, General Manager, and Director, to the important post of Joint Managing Director. He received his early training at the famous works of Messrs. Easton & Anderson, Erith, the well known engineers. He is a member of the Institution of Civil Engineers, Iron ad Steel Institute, Institution of Mining and Metallurgy, and holds other important positions.

Major A. B. H. Clerke, C. B. E. (late R. A.) joined the firm in 1911, and rendered particularly able service during the war, having conferred upon him the honourable distinction of C. B. E. His long experience in artillery matters, also many years in the Inspection Department of Woolwich Arsenal, proved to be of the highest service in war, when he helped to found and organise the Munitions Inspection Department.

LATEST DEVELOPMENTS

INSTALLATION OF ROLLING MILLS

It is only natural that this organisation, after devoting so many years to the production first of sound steel castings and ingots and secondly of manganese, low hysteresis, and other special steels both in the form of castings and forgings of all types, should so largely add to their rolling and forging facilities, including the rolling and forging of special alloy steels.

For further increasing their facilities Hadfields have recently laid down three electrically driven rolling mills, including a reversing 28-inch blooming and finishing mill and 11-inch and 14-inch bar mills, all of the most modern and improved types. The two smaller mills, which are fully described, are used for rolling billets to the various commercial sizes of bars, rounds and squares. They have proved very useful also for the production of special alloy, high-tensile steels for motor-cars and commercial vehicles, spring steel, and other special steels. The 28-inch mill with its large reversing motor, will roll 1,500 tons per week of special or other steel ingots weighing $1\frac{1}{2}$ tons each down to $2\frac{1}{2}$ inch billets. The motor, which is supplied with current on the Ilgner system, is rated at 3,200 horse power and can deal with a transient peak of about 11,000 horse power.

The new 28-inch mill is also designed to roll the well known "Era" (Trade Mark) manganese steel rails under circumstance as to cost, control of quality, etc., that should permit of considerable expansion in the use of this product. Many other forms of special steel also will be rolled.

The control of temperature is of especial importance in special steel manufacture, and in rolling this material it is particularly essential not only to start with the piece well soaked at the right temperature, but to roll at such a rate as to finish at the correct temperature. It is for this reason partly, that mills of such ample power and with such elaborate control devices have been installed, along with both soaking pits and reheating furnaces. In fact, without deviating at all from the quality standards of British industry, Hadfields' new rolling mills also should produce rolled special steel shapes and "Era" (Trade Mark) manganese steel rails on a quantity basis.

AREA OF WORKS

The birds-eye view of the East Hecla Works in Fig. 1 shows impressively their vast extent. The total area of buildings is 46 acres. The entire space covered by the Hadfield establishments is as follows:

	Land.	Buildings
(a) East Hecla Works	120	46
(b) Hecla Works	10½	4½
(c) Catcliffe (used for storage, rubbish tipping and other purpose)	83½	½
Grand Total Area	214	51

Among the various buildings, the great steel foundry at the East Hecla Works claim pre-eminence, covering an area larger than the Crystal Palace, and surpassing in this respect any other steel foundry in the world.

SECTION III
RECONSTRUCTION AND POST-WAR WORK

Achievements During The War

The remarkable achievements of Hadfields Ltd., during the war in the production of fighting and defensive material are summarised later and need only be mentioned here. Some of the plants were employed on a very large scale in the manufacture of high explosive and armour piercing shell up to 18" calibre, various types of war material, aeroplane steel, special steels for guns, howitzers, and trench mortars, "Era" (Trade Mark) manganese steel, railway work, parts of crushing and mining machinery. A most important contribution was the supply of mangaese steel "Resista" helmets for the protection of from six to seven millions of soldiers of British, American, and other nationalities. The use of this "Resista" material prevented a very large loss of life and serious wounds in tens of thousands of cases.

Changing Over to Peace Production

Great progress has been made since the termination of the war by Hadfields Ltd. at their East Hecla Works, Sheffield in changing over to peace production. This formidable task has been accomplished without the waste of a single building.

The pre-war and other plants have been partly reconstructed and still further enlarged, every building being utilised in the production of some post-war requirement. So successful has been the change-over policy that employment is now found for about 7,000 workpeople, representing an increase of something like 50% over the pre-war total. During the war Messrs. Hadfields employed 15,000 workpeople.

Ready For Post-War Work

Messrs. Hadfields are now in an excellent position for dealing with post-war work, general commercial work, including the production of steel forgings and steel castings of all kinds on a very large scale, whether of a light or heavy character. They are equally equipped to furnish special alloy steels for automobile and aeroplane work and can meet all requirements in the way of tramway and railway track work, crushing machinery, dredging machinery, fitments and appliances for collieries and locomotives, car and wagon castings, gearing and castings over a wide range for a great variety of requirements.

The new 28-inch rolling mill is believed to be the first having for one of its main objects the production of "Era" (Trade Mark) manganese steel rails.

Manganese steel long ago made its reputation for durability under the hardest wearing conditions. Enormous quantities of tramway points are supplied by Hadfields to English municipal corporation as well as to home and foreign tramway companies, especially for use at busy junctions, and to an increasing extent "Era" (Trade Mark) manganese steel rails are being laid in busy stations and for curves involving severe running and frictional strain.

The 28-inch mill also will serve to meet the increased demand for Hadfields' special high carbon and alloy steels for the motor and other industries, including the "Hecla" (Trade Mark) series of special steels for motor cars, commercial vehicles, aircraft and other purposes. "Hecla S.55" (Trade Mark) Silico-manganese spring steel; the various grades of "Galahad" (Trade Mark) non-rusting steel and numerous special alloy steels. Other steels produced and rolled in addition to "Era" (Trade Mark) manganese steel and those mentioned above are "Era 51" and "Era 53" which have been found to be admirable substitutes for the more expensive alloy steels.

Hadfields claim specially high quality for their steel, because in the manufacture of all their ingots they employ the Hadfields sound steel system, which ensures the production of perfectly solid rolled blooms, billets or rails, free from unsoundness, piping and segregation, while at the same time yielding a higher percentage of finished steel than under the ordinary methods.

A remarkable example of the specially uniform nature of the soundness of the Hadfield steel has been shown by an independent observer, Dr. J. Newton Friend, head of the chemistry department of the Municipal Technical School, Birmingham, who has been carrying out experiments for the committee of the Institution of Civil Engineers on Deterioration of Structures exposed to Sea Water Action, in the important research they have now in hand,—one that will probably last for many years and on which already several thousand pounds have been expended. The Hadfield company prepared about 1,550 specimens, the greater part of which were from their steel made under their sound steel system, which they claim to be, as far as humanly practicable, entirely free from the above-mentioned disabilities, namely unsoundness, piping and segregation. Dr. Freind undertook the full series of corrosion and other tests on these various steels, some 1,350 specimens in all. Quite unprompted, he recently made the remark, "I think you will find the report on the strained steels—their resistance to corrosion—very interesting. The uniform variation in density with strain is a striking testimonial to the even composition of the metals you provided".

Dr G. K. Burgess, Chief of the Division of Metallurgy, United States Bureau of Standards, Washington, D. C., reported with regard to his examination of 100 tons of ingots sent over to Amerca for rolling into rails that "the results of the present investigation of 37 ingots of the Hadfield type show that he (Sir Robert Hadfield) was not far astray in the confident prediction of uniformity, physical soundness and freedom from chemical segregation. In fact, it is difficult to imagine 37 ingots, from as many heats of steel, more uniform in quality and properties, and as free from those undesirable qualities and uncertainties that beset the ordinary ingot from which rails are made".

Products of Hadfields Ltd.

Amongst the various products manufactured by Messrs. Hadfields are steel castings and forgings up to 30 tons in weight, for all classes of enginering, colliery and mining purposes, complete crushing plants, crushers, jaws, gyratory and "Hecla" disc screens, elevators,

etc. for mines and quarries. Steel castings include locomotive and rolling stock wheel-centres, axle boxes, and other locomotive castings; wheels and axles complete, tyres and general castings for carriages and wagons; castings for colliery work, including wheels and axles for mining tubs and wagons, besides rollers, pulleys. Messrs Hadfields also supply casting for hydraulic and steam cylinders, gearing, housing for rolling mills, dynamo castings, turbine castings, automobile and aeroplane steels.

Hadfield's "Era" patent manganese steel is employed in the manufacture of car and barrow wheels, the wearing parts for crushing and other machinery. It is also used in making dredger accessories and rails. The whole range of railway and tramway trackwork is covered, whilst forged products include shafts and axles of all descriptions, besides turbine forgings, bridge work, etc. Other specialities include spring steel, "Hadura" rolls, milling and other cutting tools.

In addition, the Ordnance Department is on a very large scale, and includes the manufacture of the improved Hadfield armour-piercing projectile with which extraordinary results have been obtained against hard-faced armour up to 15 in. in thickness, including the attack at normal impact, also from 10 to 30 deg. and even higher degrees of obliquity. Cast and forged "Era" steel is used for shields, gun mountings, ammunition and communication tubes, conning and other towers, etc. During the war Messrs Hadfields produced large numbers of guns and howitzers up to 9.2." in calibre, also large-calibre trench howitzers, all made from their own special steel.

The total output capacity of the Hadfield steel works amounts to over 4,000 tons per week, comprising the manufacture of steel by the following processes: (1) Open-hearth, acid; (2) Open-hearth, basic; (3) Hadfield's special system; (4) side-blown converters; (5) electric furnaces; (6) crucible cast steel. In addition, they have a large iron foundry with an output capacity of 300 to 400 tons per week.

SECTION IV
STEEL-MAKING FACILITIES

Before taking up further details, a general description of the plant on which the mill depends for its supply of steel will be in order.

Hadfields' steel plant, housed in the adjoining building, 600 feet in length and covering $1\frac{3}{4}$ acres, is shown in figures 2 and 3.

Open Hearth Furnaces

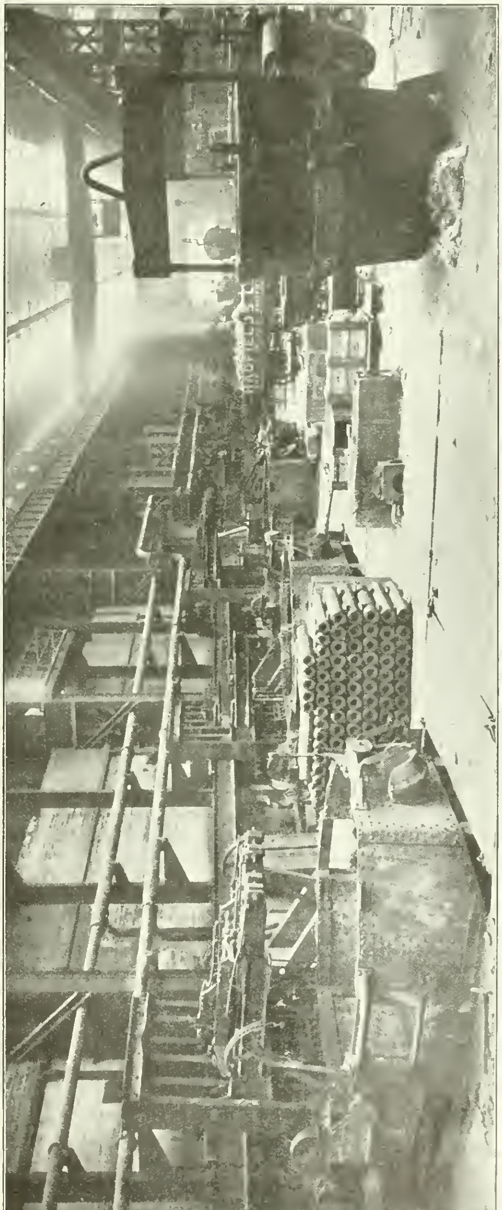
This plant comprises the most modern type of open hearth steel furnaces each having a melting capacity of from 28 to 35 tons per charge. The output capacity of the steel plant is about 1,200 tons per week.

Electric Furnaces

In this shop, twelve electric furnaces of from $1\frac{1}{2}$ to 6 tons capacity, chiefly of the latter size, were at work during the war, melting not far short of 1,000 tons of steel per week. This plant (figure 2) comprises nine electric furnaces of 6 to 7 tons capacity, and three smaller furnaces, making twelve in all. The complete plant, with a total melting capacity of 2,300 tons per week, was built at a cost of about £260,000.

Most of the scrap melted during the war was in the shape of turnings, drilling and small scrap. This residual material would otherwise have been wasted, the railroads being so overloaded that it was hardly possible to send such scrap to the blast furnaces for remelting. This melting shop, therefore, enabled very great economy to be effected, as the electric furnaces were fed almost exclusively with this steel scrap, material of little or no use for other purposes.

The results given by the combined open hearth and



Fg. 2
Electric Furnaces

Fig. 3
Open Hearth Furnaces

electric steel plants enabled Hadfields to produce cast steel blanks, which were pressed directly into the form of explosive shell of the highest quality, without the intervention of any rolling mill or forge. During the war period Messrs. Hadfields were turning out nearly 9 000 per week 9.2 inch high explosive sheels. This was quite apart from their production each each week of about 1,000 large-calibre hardened armour-piercing shell 12 in. to 15 in., probably one of the most difficult of all metallurgical productions. Such a large output of intricate work of this kind was therefore of special credit to this firm.

Corporation Electricity

During the war no less than about one million electric units of power were required weekly, of which about 50 per cent was used for melting purposes. This was supplied by the Sheffield Corporation, and a tribute should be paid to its staff, which rose to the occasion and met the severe demand put upon them by Hadfields. Notwithstanding the many difficulties that existed at the time. Hadfields plant never experienced any stoppage through lack of the necessary electrical energy to operate this large battery of electric furnaces

(to be continued)

MORE SAFETY WORK

That we shall see in the immediate future a greater development of public safety work together with a campaign against industrial accidents carried on with even greater activity through organized effort, is the statement of Marcus A. Dow, General Safety Agent of the New York Central Lines, newly elected president of the National Safety Council at the eleventh annual congress held at Detroit August 28- September 1

In accepting the leadership of the Council for the new year Mr. Dow said further that every effort would be made in the forthcoming year to reduce the national loss of life from industrial and public accidents which last year totaled approximately 80,000 deaths.

"The saftey movement has long since passed the reform stage," said Mr. Dow. "It is now a practical, constructive movement. While much has been accomplished in lessening accident casualties in industry, much still remains to be done. We are cutting down industrial accidents and now must work for a great development of public safety without neglecting industrial safety work. The right to work and mingle in public places without injury is the right of every citizen of this country. The National Safety Council is pledged to promote a national spirit which will make the recognition of the right paramount in the minds of the people."

The Estelle Process

ELECTROLYTIC REDUCTION OF IRON FROM ITS ORES

By AXEL ESTELLE

"Mining and Metallurgy" published in its number of December last year an article on "Commercial Production of Electrolytic Iron," describing the so-called "Eustis Process". This process, which produces electrolytically iron tubes from sulphide ores, is in the article said to be "unique in iron metallurgy." As the electrolytic production of iron tubes is already well-known, the uniqueness of the process can only refer to the electrolytic reduction of iron from its sulphide ores.

This reduction as indicated by Mr. Eustis, however, is by no means new; the present writer gave long ago (especially in the American Letters-Patent 1,162,150 of November 30th 1915, and Canadian Patent 157,266 of Aug. 4, 1914) an exact description of it, far more detailed than has been done in the above mentioned paper. Besides, the invention was made in 1912, and the inventor filed an application for letters-patent for it in his native country, Sweden. He then, it is true, withdrew the application before it was submitted to public inspection, on account of his not meeting with a sufficient interest in his invention. The fact is that important deposits of sulphide iron-ores are not found in Sweden; therefore the inventor was not inclined to protect a process that could be of advantage only to foreign countries and that, in fact, would be prejudicial to the export of high-class iron from Sweden.

The writer, having meanwhile taken up residence in Germany, then stated that certainly Canada, where, as well known, immense quantities of sulphide iron-ores are found, might have an interest in the process. For this reason he filed again applications, almost simultaneously, in Canada, the United States and Germany.

As a result of the war, the inventor was informed, only after the lapse of a number of years, that Canada and the United States had granted him the patents. An invitation to come to Canada in order to discuss the utilization of the invention never reached him until after the war.

Dissolving the Iron

In the above-mentioned article in "Mining and Metallurgy", to which the attention of the writer was drawn a short time ago, he sees that his idea has been taken up by other people.

The Chemistry of the Eustis Process is described in the article by the two equations

$$3\ FeCl_2 = Fe + 2FeCl_3 \text{ and}$$

$$2\ FeCl_3 + FeS = 3FeCl_2 + S$$

The first equation is identical with that of No. (2) of the above-mentioned American patent. What the second equation, in which the sulphide ore is represented by the mono-sulphide, FeS, signifies is contained in the lines 89-96 on Page 2 of the patent. The equation itself, however, has intentionally not been included, as the solution of the problem is not so simple as this equation would lead us to assume.

First it is to be observed that most of the sulphur compounds of iron are not soluble, or else rather difficult to dissolve, in dilute acids and in solutions of ferric salts. This is specially the case with iron pyrites, but also with magnetic pyrites or pyrrhotite, which, though it contains more sulphur than the monosulphide, is generally not much better for use. Therefore it is proposed in the patent to remove first this additional sulphur in any of the ways already known.

Difficulties of Using a Ferric Solvent

But, even when the mineral has been turned into monosulphide, a direct leaching with only a ferric salt solution is, for different reasons, hard to accomplish. The elementary sulphur, which precipitates as shown in the second equation above, has a very disturbing influence, especially as relatively hot solutions are necessary for the treatment. This sulphur, which coagulates in chloride solutions and does not remain suspended in a colloidal, finely divided condition, soon forms an impervious covering round the mineral grains and stops in this way the further reaction of the ferric solution. Moreover, we must remember that a ferric salt in aqueous solution is always partly dissociated hydrolytically into hydroxide of iron and hydrochloric acid, as this equation shows:

The degree of dissociation of the hydrocloric acid, however, is very high and for this reason the concentration

$$FeCl_3 + 3H_2O \rightleftarrows Fe(OH)_3 + 3HCl$$

of the H-ions will surpass the ferric-ions. The chloride of iron accordingly does not react with the iron sulphide in the simple way that the second equation indicates in the article mentioned.

The hydrochloric acid formed by hydrolysis reacts on the iron sulphide and releases an equivalent quantity of hydroxide of iron, by which reaction sulphuretted hydrogen at first is formed. All the latter, or at least the larger part of it, reduces unaltered chloride of iron and precipitates sulphur. The hydroxide of iron at first set free is turned by the surplus of chloride into soluble oxychlorides, which however, as fast as the chloride becomes reduced change into soluble basic combinations as, for example, $Fe_2\ Cl\ (OH)_5$. Finally, when the greater part of the chloride has been reduced, sulphureted hydrogen escapes and the reaction might be the following:

$$5FeS + 4FeCl_3 + nH_2O = 5\ FeCl_2 + 2Fe_2Cl\ (OH)_5 + 5H_2S + (n\text{-}10)\ H_2O$$

The consequence of the hydrolytic dissociation of the chloride of iron is that when leaching, if there is no free acid, besides sulphur, all kinds of insoluble basic ferric compounds are formed, which also work disturbingly in many regards, and part of the sulphur escapes as sulphuretted hydrogen.

Another disadvantage connected with the leaching of the ore with chloride of iron is that part of the sulphur, although but a small part, oxidizes to sulphuric acid and that the solution is getting more and more sulphate-containing, which should be avoided when reducing pure iron.

Should the ore, together with iron, contain any other sulphides of metals that might be of use, then the direct leaching with chloride of iron is still more unsuitable, as these foreign metals are dissolved, although not quantitatively. There is obtained not only a solution of ferrous chloride containing compounds of other metals, which solution must be specially treated before electrolysing in order to utilise these metals and get the purest iron possible, but also a residue of gangue, sulphur and sulphides of metal that remain undissolved and that cannot always be economically treated.

The Estelle Process

All the above-mentioned disadvantages and difficulties are avoided by the invention of the author. The process according to this invention consists essentially in first leaching the raw material with weak non-oxidizing acid and in then separating the iron electrolytically with insoluble electrodes from the solution of the salt of iron so formed, a suitable method being employed for continuously regenerating the solution as diagrammatically shown in the drawings filed with the patents.

One of the figures illustrates the various steps by which the iron and sulphur are separated from each other and from the residue of the ore, the leaching being done simply by a dilute non-oxidizing acid. The other figure illustrates the same when a part of the ferric solution produced by electrolysis is used with the same dilute non-oxidizing acid as leaching fluid. The process is the same, step for step, the difference being the addition of supplemental leaching liquid at one stage, to the main leaching liquid first mentioned above. Of course the material produced or separated by the various steps of the process may be collected, washed and used continuously where made available.

After the sulphide iron-ore has been converted into the readily soluble form as more particularly explained in the patent, the above described leaching and electrolytic treatment can be carried out. It has already been frequently proposed to treat copper and zinc ores or their smelted products in a similar manner. The known processes involving this treatment are, however, totally unsuitable for the present purpose, because, when extracting iron, quite other conditions exist, which render necessary a treatment essentially different from these processes.

In the Patent the method is described in the following manner:

"For carrying the new process into practice, two cases must be considered:—(1) When the raw material contains valuable metals which it is desired to extract as by-products. This case is to be regarded as the normal one. (2) When the raw material contains no such metals.

Separation of Iron and Other Metals

"The following is an example of the manner in which the present invention may be carried into effect. The raw material, reduced to a suitable size, is treated at a temperature of about 40 deg. to 80 deg. C. with a dilute, non-oxidizing acid, preferably hydrochloric acid. Assuming that the latter acid be employed, the result of the reaction is the formation of ferrous chloride and sulphuretted hydrogen, in accordance with the well-known equation:

$$FeS + 2HCl = FeCl_2 + H_2S \quad (1)$$

"Other sulphur-containing metals possibly present, as well as a small residue of gangue, remain behind in the lixiviating apparatus. These particular metals, being in this highly concentrated form, can subsequently be very advantageously treated. The solution of ferrous chloride is electrolyzed in suitable decomposition or electrolytic cells with insoluble anodes, these cells being however of extremely simple construction because the solution contains only one single metal. A portion of the iron is now deposited, while twice this amount of iron is converted into the corresponding ferric compound, as the following equation shows:

$$3FeCl_2 = Fe + 2FeCl_3 \quad (2)$$

Separation of Sulphur and Regeneration of Acid

"The ferric chloride obtained is now passed, together with the equivalent quantity of sulphuretted hydrogen evolved in accordance with equation (1), into an absorption tower or other suitable, similar apparatus, the following known reaction then occurring:

$$2FeCl_3 + H_2S = 2FeCl_2 + 2HCl + S \quad (3)$$

"The acid previously combined with the electrolytically deposited iron is in this manner again liberated in order to be available for further use, while the corresponding quantity of sulphur, simultaneously separated, needs only to be removed and converted by known methods into one of the commercial forms.

"By this process there are therefore extracted in a simple manner not only the electrolytically deposited iron but also the corresponding quantity of sulphur. The valuable metals remain behind as compounds with sulphur and can be recovered by a separate process. The acid employed as solvent is continually regenerated, and then re-employed.

"A special advantage of this process is that sulphur is eliminated in a separate apparatus and is not rendered impure by the residues when the raw material is dissolved. An added advantage is that the electrolyzing devices can be of extremely simple construction, as it is a question of keeping several different metals separate from one another.

"In the above-stated second case, viz. when the sulphide of iron contains no other valuable metals or at least no sufficient quantities to warrant recovery, the above described process may obviously be also employed. Under some circumstances it is, however, preferable somewhat to modify the process, for, since no valuable attendant metals need to be taken into consideration, *it would be possible directly to lixiviate the sulphide of iron with the ferric solution directly obtained from the electrolytic or decomposition cells* (*) For this purpose, however, a certain quantity of free acid must be present, and as the solution to be electrolyzed should contain no free acid, or at least no material quantity, the acid must be neutralized or saturated before the solution is subjected to electrolysis. This again would mean a continual increase of the quantity of solution and a corresponding loss of acid and iron. This disadvantage can, however, be obviated by supplying only a portion of the ferric solution directly to the lixiviating apparatus, while the remainder is passed through the absorption tower provided in case No. 1, in order to reach the lixiviating apparatus only at some later time. In this manner the necessary quantity of free acid is supplied and as this should be neutralized, the quantity of sulphuretted hydrogen necessary to furnish this acid is produced.

"By the process described in this invention it is therefore made possible to produce electrolytic iron from ores and smelted products which have hitherto been regarded as almost worthless. Moreover, the new process is applicable to any sulphide-containing smelter product, provided that the percentage of soluble sulphide of iron is sufficiently high.

"As this invention is not limited in its application to one product only, it is of no consequence that the iron is obtained in a crude form as "electrolytic crude iron." The decomposition cells can on that account be of very simple construction. As no free acid is present, and no destructive gas is evolved at the anodes, the cells are well preserved.

"The separated iron is preferably melted in an electric furnace, this iron being alloyed simultaneously if desired with other metals for special purposes."

(*) The italics show the words in the Estelle patent that correspond with the second equation of the "Eustis Process" mention above.

Electrolytic Reduction of Iron Oxides

The above described invention relates to the utilization of sulphide iron-ores. The author also carried out another electrolytic treatment for reducing iron from its ordinary oxide-ores. This invention was made a short time before the war and an application for letters-patent was filed for it in November 1914. The American Patent, published on August 6th, 1918, has the number 1,275,161. The Canadian Patent is No. 188,462, Jan. 28th, 1918.

The invention proposes the production of iron by the electrolytic dissociation of a hot slimy precipitate of iron hydroxide suspended in an electrolyte of caustic alkali, comprising for example 35 per cent water, 35 per cent caustic soda and 30 per cent ferric hydrate, the electrodes being of iron, nickel or any other suitable material that resists the effect of the current and of the hot electrolyte. By the action of the electric current metallic iron is precipitated on the cathode in form of a smooth layer, and oxygen is evolved near the anode, while the iron hydroxide is gradually decomposed. In order to render the process continuous, iron hydroxide may be added to the electrolyte in the electrolyzing tank in proportion as metallic iron is precipitated.

Under the influence of the current two events occur. By the action of so-called electrophoresis the hydroxide of iron comes up near the cathode and would firmly adhere to it in this chemical state, if the electrolyte were not simultaneously decomposed. On the other hand the electrolysis would end in a simple decomposition of water, if the hydroxide of iron were not reaching the cathode. The sodium-ions arriving at the cathode immediately reduce the ferric oxide and insure that only metallic iron is deposited at the cathode, whereas the hydroxyl-ions deposited at the anode dissociate into elementary oxygen and water.

The electro-chemistry of the process may be shown by the following equations:

$$6NaOH + 6(F) = 6Na^{\cdot} + 6OH'$$

$$6\ Na^{\cdot} + 2Fe(OH)_3 = 2Fe + 6NaOH + 6(+)$$

$$6OH' = 3O + 3H_2O + 6(-)$$

$$6NaOH + 2Fe(OH)_3 + 6(F) = 2Fe + 3O + 3H_2O + 6NaOH$$

From the final equation it is clearly seen that, by the action of the current,—6 valence charges (F) for 2 Mol. $Fe\ (OH)_3$—the electrolyte, the caustic soda, remains unchanged in its chemical state and only the ferric oxide is decomposed into its elements, iron and oxygen, whereas the water of hydration separates unchanged. By the latter, it is true, the electrolyte becomes diluted, but, the electrolysis occurring at about 100 deg. C., a temperature far below the boiling point (140 deg.) of the electrolyte, there is so much water evaporating as steam with the oxygen that commonly an equalization is obtained by this means.

Process Electrolytic, not Galvanic

With regard to the above description, the reduction of iron is not to be looked upon as the result of a common, galvanic process, but as that of an electrolytic reduction. To prove this statement, an experiment may serve, in which the cathode was separated from the hydroxide of iron by a porous cell. In that case no iron was deposited and the result of the electrolyzing was only a decomposition of water. The process is therefore to be considered as unique in electro-chemistry in this regard also, that a molecule by aid of electrical energy is separated into its constituents parts in such a way that neither of them has an opportunity of forming new combinations and both therefore can be utilized in their unchanged state.

The fact that the electrolyte consists of a strong solution of a caustic alkali has the great advantage of permitting metallic iron to be used as the material of construction, not only for the decomposition-cells themselves, but also for piping, heating apparatus, devices for moving the slimey mixture and for other parts coming into contact with the hot electrolyte. The decomposition-cells therefore can be made air-tight, and for that reason the oxygen also can be caught and utilized. For one metric ton of iron obtained not less than about 300 cubic meters of oxygen are produced.

No Diaphragms Required

The electrolysis occurs without making use of diaphragms. The electric current required is 1.6 to 1.8 Volt at a current density of 3 Amp. per sq. dm. At an efficiency of current of about 90 per cent, the consumption of energy is about 2,800 K.W.H. per metric ton of iron.

The deposited metal does not incline to a lumpy formation as is the case with the ordinary galvanic process. However, it is a little more porous than ordinary electrolytic iron.

Molding, Rolling and Forging Electrolytic Iron Without Fusion

It is simple to provide for an easy separation of the metal form the cathode sheets, if it is to be utilized as "electrolytic crude iron" or as powdery iron. Having not been red hot, the iron may in a simple way be ground to a fine powder. This peculiarity of his iron suggested to the author the idea of a process for the production of objects of pure iron, iron alloys, simple and alloyed steel by making use of powdery materials, by making at first in quite a special way, a solid compressed mass, free from oxygen, which can be worked up by common, well-known methods either cold or red-hot. The objects made in such a way, such as hollow cylinders, which are to be slit and rolled, may accordingly be finished without any melting of the material. This is of great importance, specially for products of excellent magnetic qualities, as the iron, as is known, tends to absorb gases when fused, but not when only red hot. The possibility of giving a certain shape during the compressing of the powdery materials has in itself an importance that is not to be undervalued.

As mentioned, the oxide of iron that is to be electrolyzed must be in a hydrated form. Anhydrides, as hematite and magnetite, may therefore be hydrated by a suitable treatment with ordinary or caustic soda, by which means a ferrite of sodium is first produced, which is then decomposed by the addition of water into hydroxide of iron and caustic soda. So the soda is not consumed; at best it is causticised in accordance with the following equations:

$$Fe_2O_3 + 2NaOH = Na_2Fe_2O_4 + H_2O$$

$$Fe_2O_3 + Na_2CO_3 = Na_2Fe_2O_4 + CO_2$$

$$Na_2Fe_2O_4 + 3H_2O = 2Fe\ (OH)_3 + 2NaOH$$

Sources of Raw Material for Estelle Process

In many factories by-products are formed, which if not made impure by carelessness may be directly utilized for the present purpose, such as iron hydrates obtained in factories for aniline and for compounds of bromine. Turnings also may serve as raw material for the production of electrolytic iron by this method, after a preliminary washing and conversion into hydrates.

Whether natural products as common iron ores, residues from the purification of bauxite in the alumina factories, and sulphide iron ores (pyrite and pyrrhotite), should be used as raw material, is in any single case a question only

of separation or concentration. With magnetite as raw material an oxygen compound of iron, practically free from gangue, may be obtained economically as is well known. Sulphide of iron can be freed from the gangue by a variety of pyritic smelting, and from sulphur to a sufficient extent by roasting and in other ways. For the treatment of pyrite and pyrrhotite, containing besides iron other useful metals such as copper, nickel and cobalt, and also precious metals (Canadian ores especially), the method opens up new ways, which may lead to the ultilization not alone of the above-mentioned metals but also of the iron, as well as of the sulphur. Non-magnetic iron ores, in the first place the hydrated ones (brown hematite, bog ore, etc.) are hard to concentrate, so that they are less suitable raw materials for the electrolytic reduction of iron than the above mentioned ores. In the treatment in question it is most important that no considerable quantity of gangue should enter the apparatus. Lately, the author has succeeded in finding out a treatment for bringing such ores in a way other than roasting to a very strong magnetic state. This gives him promise of making also of these non-magnetic ores suitable raw materials for his process.

Suggested Uses for Oxygen

Regarding the utilization of the oxygen produced as a by-product in the alkaline process of electrolytically reducing iron, we must mention some special uses. In smelting works the oxygen is not only highly serviceable for autogenous welding and cutting, but also for purely metallurgical purposes. If, for example, in the Siemens-Martin process it were possible to increase the content of oxygen in the compressed air by about 2 per cent., a temperature could be reached, that would permit refining processes that otherwise can be carried on only in the electric furnace. It is only during short periods, that the air must be thus rich in oxygen.

For the utilization of the nitrogen of the air, as in the process with electric arcs, cheap oxygen is of importance as has been shown, since the yield is improved by using the so-called ideal gas mixture, consisting of equal volumes of oxygen and nitrogen, instead of the air. It may also be an advantage to have cheap oxygen at one's disposal, when oxidizing ammonia to nitric acid.

Finally the writer wishes to draw attention to the fact that in the supply of electric current, large fluctuations have no significant influence on the quality of the iron separated. For this reason an industry based on the alkaline process of reducing iron electrically seems to be suited to serve as a consumption-regulator for electric central stations.

This electrolytic iron industry undoubtedly would be able to fulfil the principal conditions of commercial success without any difficulty, the raw material, as a rule, being nearly everywhere obtainable. The finished product, if cheap enough, would find an unlimited sale, and the plant itself would need relatively few hands.

PRODUCTION OF IRON AND STEEL, AUGUST, 1922

Pig Iron and Ferro-Alloys

The Dominion Bureau of Statistics reports that the production of pig iron suffered a decline of 14.45 per cent in August as compared with the record of the previous month. The output in the month under review was 27,123 gross tons as compared with a production of 31,705 tons in July, involving a decrease of 4,582 tons. The August output represents an increase of 16.09 per cent over the record for May, constituting the minimum production of the present year. The principal grades produced in August were 20,494 tons of basic pig for further use, and 6,296 tons of foundry iron intended for sale. Fifty-two tons of foundry iron was made for further use and 281 tons of malleable iron was manufactured for sale.

A comparison with the statistics of last year indicates the quiet tone from which the industry has not yet emerged. The pig iron output in August, 1921, was 50,156 tons comprising an excess of 23,033 tons or 45.9 per cent over the record for the corresponding month of this year. The cumulative production during the first eight months of last year was 413,448 tons as compared with a total of 251,015 tons during the corresponding period of 1922. The difference represents a decline of 39.28 per cent.

The ferro-alloy production in August increased by three per cent. over the record for July. The absolute quantities were 1,864 tons in August and 1,809 tons in the previous month, comprising an increase of fifty-five tons. The cumulative output for the first eight months of this year was 13,344 tons as compared with a production of 17,784 tons during the corresponding period of last year, constituting a decline from last year's record by 4,440 tons or 24.9 per cent. The output in August consisted chiefly of 50 per cent and 75 per cent. ferro-silicon produced for sale.

Notwithstanding advancing prices and favorable marketing conditions production slackened perceptibly during August. The fuel shortage was the principal cause of the recession bearing specially hard on the industry in question. Upon the settlement of the coal and rail strikes considerable improvement may be expected.

Steel Ingots and Castings

Steel production declined to 59,201 long tons in August as compared with an output of 62,767 tons during the previous month. The decrease is equivalent to 3,566 tons or 5.68 per cent. The output in August is also less than that of the corresponding month last year by 12,822 tons representing a decrease of 17.8 per cent. The cumulative production for the first eight months of the present year was 299,048 tons involving a decrease from the output during the same period of 1921 by 122,093 tons or 29 per cent. The absolute quantity produced in the eight month period last year was 421,141 tons. The average production in August for the three year period from 1919 to 1921 was 76,964 tons which is in excess of the output of the month under review by 30 per cent.

The 56,997 tons of ingots were open hearth basic steel intended for further use. The production of ingots in August was 56,997 tons or 6.9 per cent less than the output in the previous month when 61,243 tons were reported. In August 1921, 70,339 tons were produced comprising an excess of 13,342 tons or 23.4 per cent. over the output of the month under review.

The output of direct castings increased from a production of 1,519 tons in July to 2,204 tons in the following month. The increase represented 685 tons or 45 per cent. The total production of castings for the last eight months was 13,044 tons as compared with an output of 17,628 tons during the corresponding period of the previous year. The decline comprises 4,584 tons or 26 per cent. The principal grade produced in August was 1,128 tons of bessemer castings of which 1,118 tons were made for sale. Castings made in electric furnaces for sale were reported to the amount of 738 tons and 130 tons were manufactured for further use.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

STEEL LEADERS CHOOSE BASIC BOOKS OF INDUSTRY

The basic books in the steel industry as selected by leading members of the industry for inclusion in the business library of the McAlpin Hotel of New York are announced today by L. M. Boomer. Among those who have given their selections, from which the final choice will be made are:

Charles M. Schwab, Chairman, Bethlehem Steel Company, New York; George G. Crawford, President, Tennessee Coal, Iron & Railroad Company, Birmingham, Alabama; J. A. Campbell, President, The Youngstown Sheet & Tube Company, Youngstown, Ohio; H. Sanborn Smith, First Vice-President, Gulf States Steel Company, Birmingham, Alabama; E. G. Grace, President, Bethlehem Steel Company, Bethlehem, Pa.; J. S. Unger, Manager Carnegie Steel Company, Central Research Bureau, Pittsburgh, Pa.; A. A. Corey, Jr., Vice-President, Midvale Steel & Ordinance Company, Philadelphia; S. W. Tener, American Steel & Wire Company, Cleveland, Ohio; George M. Verity, President, The American Rolling Mill Company, Middletown, Ohio, and John A. Mathews, President, Crucible Steel Company of America, New York City.

These selections came to Mr. Boomer as a result of an inquiry instituted among the leaders in the steel industry to assist him in building up a business library of the ten books in each of twenty industries selected by the leaders of those industries.

MR. SCHWAB chose:

Title	Author
Metallurgy of Steel 2 Volumes	Harbord & Hall (Charles Griffin & Co.)
Metalurlgy of Iron & Steel	Stoughton (McGraw-Hill)
Metallurgy of Cast Iron	Thomas D. West (Cleveland Printing & Publishing Co.)
Manufacture and Properties of Iron & Steel	Harry Huse Campbell (McGraw-Hill)
Metallography & Heat Treatment of Iron & Steel	Albert Sauveur (Sauveur & Boylston Cambridge, Mass.)
Principles, Operations & Products of the Blast Furnace	J. E. Johnson, Jr. (McGraw-Hill)
Basic Open Hearth Steel Process	Carl Dichmann (D. Van Nostrand Co.)
The Electric Furnace	Alfred Stansfield (McGraw-Hill)
The Steel Foundry	John Howe Hall (McGraw-Hill)
The Engineering Index	(American Society of Mech Eng.)

The Year Book of the American Iron and Steel Institute as well as The Journal of the British Iron and Steel Institute published in London.

MR. UNGER chose:

Iron & Steel Works Directory of the United States and Canada, 1920.	(American Iron & Steel Institute, 40 Rector Street)
The Making, Shaping and Treating of Steel	J. M. Camp (Carnegie Steel Co. Pittsburgh, Pa.)
Kent's Mechanical Engineer's Pocket Book	(John Wiley & Sons.)
Coal and Coke	Frederick H. Wagner (McGraw-Hill)
The Manufacture and Properties of Iron and Steel	(Campbell McGraw-Hill)
The A B C of Iron and Steel	(Penton Publishing Co. Cleveland, Ohio)
Principles of Iron Founding.	Moldenke (McGraw-Hill)
Principles, Operations and Products of the Blast Furnace	Johnson (McGraw-Hill)
Blast Furnace Construction	Johnson (McGraw-Hill)
The Ore Deposits of the United States and Canada	James F. Kemp (McGraw-Hill)

MR. CRAWFORD chose:

The Metallography of Steel and Cast Iron	H. M. Howe
Metallurgical Calculations	J. W. Richards
Steel and Its Heat Treatment	D. K. Bullens
The Principles of Iron Founding	Richard Moldenke
The Metallography and Heat Treatment of Iron and Steel	Albert Sauveur
Blast Furnace Construction in America	J. E. Johnson, Jr.
The Principles, Operation and Products of the Blast Furnace	J. E. Johnson, Jr.
The Basic Open Hearth Steel Process	Carl Dichman
The Chemical Analysis of Iron	A. A. Blair
The Metallurgy of Iron and Steel	Bradley Stoughton

MR COREY, JR. chose:

Principles, Operation and Production of the Blast Furnace	Johnson
Manufacture and Properties of Iron and Steel	Campbell
Iron and Steel	Tieman
Steel - A Manual for Steel Users	Metcalf
The Metallography of Steel and Cast Iron	Howe
The Metallography and Heat Treatment of Iron and Steel	Sauveur
Metallurgical Calculation	Richards
The Making, Shaping and Treating of Steel	Camp & Francis
Cambria Steel Company Handbook	"
Electric Furnace in the Iron & Steel Industry	Roenhauser, Schoenawa & Van Baur

MR. MATHEWS chose:

Metallurgy of Iron and Steel	Stoughton
Metallography of Steel and Cast Iron	Howe
Electric Furnaces in the Iron and Steel Industry	Van Baur
Materials of Construction	Upton
Heat Treatment of Tool Steels	Brearly
The Inside History of the Carnegie Steel Company	J. H. Bridge
Helmets and Body Armor in Modern Warfare	Dean
Iron in All Ages	J. H. Swank

In commenting on the gratifying response to his request, Mr. Boomer said:

"When I first made public the plans for a business library in the McAlpin I was advised that the practical business man had little time for theoretical knowledge such as would be obtained from books. I have before me a very convincing exhibit of replies from leaders in industry to the effect that the business executive not only appreciates the value of theoritical study of his business but also values the viewpoint of another man.

"While replies to my letters are still coming in by every mail, it is quite evident from the correspondence already received that the kind of books which treat industrial subjects from the human point of view are more in favor than books of a merely technical character. I have noted a number of comments to the effect that a young man should first read the kind of books that tend to make his business interesting, and read the technical books later to supplement his practical experience.

"In addition to a general interest among industrial leaders in the bibliography of our library I have received many helpful suggestions which I believe will make the library both useful and interesting to business men."

EDITORIAL

ONTARIO'S IRON ORE COMMITTEE

Hon. Harry Mills, Minister of Mines for Ontario, has announced his selection of the following committee to investigate the commercial possibilities of mining iron ore in Ontario: Prof. H. A. Guess, professor of metallurgy, University of Toronto; Prof. H. E. T. Haultain, professor of mining, University of Toronto; Mr. J. G. Morrow of the Steel Company of Canada; Mr. G. S. Cowie of the Mines Department, Algoma Steel Corporation; Mr. Lloyd Harris, of Brantford; and Mr. Hall, of Montreal, the last two to represent the transportation and commercial aspects of the case.

While it is highly satisfactory that the Department of Mines at Toronto has interested itself actively in the iron ore problem in this way, the personnel of the committee, as announced, is distinctly disappointing. It is composed of a group of technical and financial specialists prominent, and even eminent, in their respective lines. Unfortunately, however, not one of them is a specialist in iron ore, though a number are keenly interested in iron ore and have followed closely the developments in the situation from year to year. We were led to believe that the Minister of Mines intended to employ the services of such a specialist. No specialist on iron ore has been included in the committee, and we are disappointed.

The iron ore problem has beset us continuously since our modern iron and steel industry was instituted. Numerous and determined efforts to solve the problem have been made, but so far without success. Many commissions and committees have investigated and reported, without practical result. We proceed anew to observe and to argue, and can continue so to do "ad infinitum" with the same result as before. In the present case it appears that we shall follow the old, beaten track, which will lead us inevitably to the same goal as heretofore—which is exactly the spot from which we started.

There is needed a new plan of attack on this problem. Our iron ore problem in Ontario is not exactly similar to that of any other district, and no course of mere observation of the results in other fields will serve to provide a solution for our case. The human effort that has been and is being expended in these other fields to ensure a successful issue must be paralleled, though not duplicated, by similar human effort expended on our own problem. A consultative committee is not capable of expending this effort. The committee is, in this case as usual, composed of men well occupied in their special professional work, who can spare only a small fraction of their time and effort for the committee's work. Even if they should stretch a point and neglect a part of their regular duties in favour of iron ore, the problem will not have that wholehearted and continuous attention without which, we are convinced, even a board of iron ore specialists would confer in vain. The members of the present committee are to be commended for the public spirit that has impelled them to accept this charge; we wish there were some prospect of success more in keeping with their sense of duty to the public cause.

The fact is that, as we have in Canada no iron ore industry, so we have here no all-round specialists in iron ore. If we wish to have the soundest professional advice on our present problem, we must either call in a specialist from outside and give him the facilities and the time to acquaint himself with Canadian conditions, or, on the other hand, we must give to a Canadian engineer or geologist already thoroughly acquainted with the case in Canada an opportunity to study and assimilate the information and ideas that are to be gained abroad. A man thus prepared to study our iron ore problem can logically be expected to find its solution. Anything less than this is trifling with the question.

BELCHER ISLANDS IRON ORE

Dr. G. A. Young's report on the iron ore of Belcher Islands, summarised in this issue, makes it obvious that Canada's iron ore problem will not be solved by means of an unlimited supply of high-grade ore from that part of Hudson Bay. That quarter of Canada is an old stamping ground for Dr. Young, for he was a member of Dr. A. P. Low's expedition of 1902-03 which examined a long stretch of the adjacent coast of Hudson Bay, spending two summers and a winter on that cheerless coast. The results of those seasons' work have never been made public formally; but it has become known informally that iron ore, which was the prime object of the party's exploration, was found to no greater an extent than that on Belcher Islands now under discussion, though vast areas of iron formation similarly were located.

After examining in detail forty miles of outcrop of the iron formation of Belcher Islands and having his samples analysed. Dr. Young's conclusion is that no ore of commercial grade is available. It is possible, though not probable, that high-grade ore lies concealed by drift.

It is unfortunate that the ore available in the far-off islands is of so low a grade as to preclude its use until the ore of many an iron range, much nearer civilization, is subjected to a process of beneficiation. If, for instance, Belcher Islands had ore of the purity of the Minas Geraes region of Brazil and in similarly vast amounts, capital might be induced to attempt its commercial use. But even if the ore were of perfect quality it is not likely that it could be used.

Belcher Islands are 350 miles by water from Moose Factory. Moose Factory is 200 miles from Hearst. From Hearst it is 150 miles by rail to Michipicoten Harbour on Lake Superior. This, the most direct route to a market, would require the building of 200 miles of railway, a special fleet of boats and two ore-handling terminals. The whole cost of this would have to be charged against the ore-deposits with the possible exception of a small part of the railway that would pass through agricultural land. Via Cochrane and North Bay to Georgian Bay the capital charge would be somewhat less but the railway haul would be longer. The season for navigation on James Bay and Hudson Bay is short, say four months at most, so that the equipment would be idle for eight months of the year unless stock-piling were resorted to, to cover that period. Belcher Islands are barren and even fuel would have to be brought by railway and boat. Experience has shown that the Esquimaux are not capable of consistent toil, so labour charges would be inordinately high.

All told, it is just as well that the vague hopes we had formed of Belcher Islands as a source of iron ore for Canadian furnaces should be definitely abandoned. The present authoritative report gives little, if any, encouragement for a revival of these hopes even in the remote future.

WILL THE COAL MINERS HOLD UP THE PUBLIC?

The president of district eighteen, United Mine Workers of America, is quoted in a press despatch as announcing that at the expiry of their agreement with the operators on March 31st next, they will demand not only the continuance of the present rates of pay, but a six-hour day and a five-day week. Thus do the coal miners of Alberta and eastern British Columbia throw down the gage of battle before their employers, the coal operators. They do this openly and deliberately, with a full knowledge of what their challenge involves. There are rumours of a similar move to be made by the coal miners of the United States at their conferences to be held soon. They too are ready to renew a fight of which they have won the first round.

It is probable that none of these unions of coal miners realize clearly a fact that is as yet only dimly seen by the general public, and in fact has not yet become even dimly visible to the vast majority. The coal miners have determined deliberately to constitute themselves a privileged class on this continent, and demand it as a right that they be paid for their labour at a rate quite out of proportion to the service they render the whole people of the continent. The terms under which they propose to labour in the mines would afford them a living at the expense of less effort than will support the average man and his family under the conditions at present prevailing in Canada and the United States. They implicitly propose that other classes of labour and professional men shall expend the remainder of effort necessary to provide them (the coal miners) with a comfortable living. Their present demands mean that the rest of the community of all callings, are to work longer hours that the miners may have two days of rest in seven, and an exceptionally short period of labour on the other five days. The coal miners propose a measure that will turn them into the human leeches they profess to despise, against whose supposed domination, as capitalists, the present ultimatum is directed.

Will the public allow itself to be held up, as was done recently when the coal operators acceded to the demands of the miners? Will the case of the public remain virtually unrepresented when the other two parties to the dispute align their arguments next spring? Shall we, the owners of the natural resource that is the physical basis of the dispute, allow our agents, the operators and the miners, to decide their differences without reference to our undoubted and inalienable rights? Put in this light, the conclusion is obvious.

The price of coal, is of course, the factor that controls, more than any other single factor except the price of human labour, the cost of iron and steel products. The cost of both coal and labour in the overseas centres of iron and steel production has been brought down to a level not greatly above that of the normal pre-war years. Canada's chief centre of iron and steel production is subject to international competition, though sheltered somewhat by the tariff. The plants situated far from the sea, though protected by natural barriers from cheap overseas products, are subject to competition from these in some degree, particularly in manufactured articles. Hence every producer of iron and steel in Canada has a vital interest in the price of coal, which is virtually regulated by the price of mine labour.

Unfortunately the general public, which alone can provide and enforce a just decision in this triangular dispute, is not as yet sufficiently aware of its responsibility to act in the decided way the occasion requires. There are glimmerings of interest in the dispute in certain quarters, but the issue is as yet grasped clearly by only a very few. It is incumbent upon these few to act, and to act promptly. The public press is the principal and most effective means of educating the public rapidly and effectively in such a case. We hope that publicists and the press will take hold of this most important question and employ all the means at their command to prepare the public's brief. Only thus will a purely selfish decision be avoided. Only thus will British justice be upheld in its high place in our land.

QUANTITY PRODUCTION OF MANGANESE STEEL

Today we print the second, and concluding, instalment of a comprehensive description of the East Hecla steel works of Hadfields, Limited, Sheffield, with particular reference to the new 28-inch rolling mill, designed for the production of rails and similar sections of manganese and high-carbon steels. Due to the unusual difficulty of rolling steel of these varieties, as well as on account of the

subsequent heat-treatment to which manganese steel must be subjected to bring out its useful qualities, an ordinary rolling mill does not suffice for these steels. The new mill has the necessary appurtenances and is built to stand the unusual strains incident to rolling these steels.

Hadfield's manganese steel is making for itself a rapidly extending market throughout the world. It is this, and the central position of Britain for supplynig a wide market, that will allow the quantity production of a special steel. There will be, presumably, a reduction in price corresponding to the economy effected by quantity production, which should assist materially in broadening the market for manganese steel still further.

There is illustrated here the prime advantage of Britain as a manufacturing centre for world-wide trade. It is improbable that anywhere else in the world could the quantity production of a highly-specialized product such as manganese steel rails and rolled shapes be made to pay. The free trade policy of Britain allows of manufacture at a minimum of cost in both labour and materials; highly-skilled mechanics provide for an output of the traditional high quality of British goods; and the sea routes give access to a large part of the world's markets.

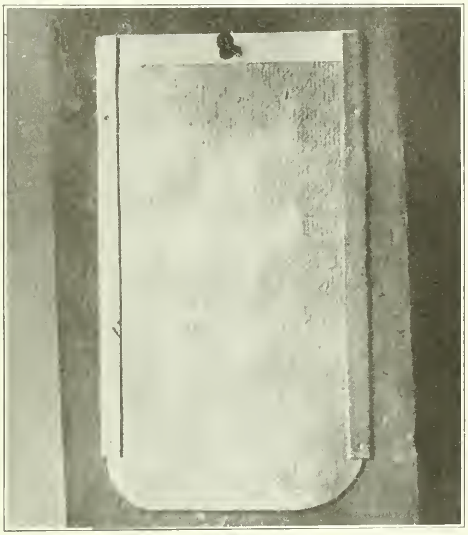
While we in Canada lack some of the essential advantages that have permitted the growth of the great Hadfield undertaking, we have other advantages that compensate in some degree. There are already enough instances of Canadian enterprise along these lines to indicate with some certainty the future growth of special steel manufacture in Canada.

It is stated, on good authority, that there are now more than 2,000 firms maintaining research laboratories in the United States. Approximately thirty million dollars were spent in research during the year 1921. Governments, State and Federal, advanced one-third of this. So far we Canadians have failed to establish a single technical research laboratory, modernly equipped on a comprehensive scale. There are a few (all too few) private laboratories working on specific problems, mainly as adjuncts to industrial establishments. We have still to see the vision that has led far-sighted industrial leaders in the United States to invest their millions in research. Our governments have still to glimpse what is now accepted as axiomatic by the political leaders of our neighbors. We wonder if the hookworm that plays havoc with our revered Senate must be referred to United States scientists! Surely we should deal with it here!

KEEPING STOCK RECORDS CLEAN

A frequent objection to keeping a list of the contents of racks, bins, etc., close at hand for easy reference is that the record sheet soon become almost unreadable by reason of the dirt and grease it collects after a short time in use. It is impossible, of course, for any storeman handling metal to have clean hands and wherever lists of material and the like are hung up in the storeroom and it is necessary that additional information be added from time to time, some method should be adopted whereby the paper is protected at all times.

A stock record holder that has proved advantageous is illustrated in the accompanying photographs. This holder was made from a piece of scrap sheet brass, one part hav-



ing both sides bent over and the other piece cut to slide between. Four punch marks provide the necessary friction to hold both parts together. The paper is attached by turning it back over the top and bottom and glueing it to the back. In the first illustration the holder is shown closed, in the second the cover is partly withdrawn, illustrating how the paper is protected from contact with the writer's hand.

The Story of Hadfields Limited

Section V

DESCRIPTION OF THE 28-INCH REVERSING MILL

The Rolling Mill Shop

The general position of the new rolling mill shop is indicated by Figure 4, showing a block plan of Messrs. Hadfields' East Hecla Works in which the 28 inch rolling mill position is shown shaded. The general arrangements of the shop are shown by Figure 5, and the interior view is shown comprehensively by Figure 7, looking from the finishing and discharging end of the mill.

The total area covered by the complete scheme is 175,000 square feet or 4 acres, the rolling mill shop itself occupying an area of 80,000 square feet or 1.75 acres. If the area of the smaller mills is also included, the total space covered is considerably over 5 acres.

The building in which the mill is now installed is one of several large structures erected by Messrs. Hadfields during the war period, this particular building being fully equipped at that time for the complete manufacture of high explosive shells of 15" calibre and up wards. To meet the present requirements the length of the building has had to be extended sufficiently to accomodate the new 28 inch mill, furnaces and other appliances. As now completed, it comprises three bays, A, B, and C, each having a crane span of 51 ft. 3 in. between centres of rails, with a height from the floor to the level of crane rails of 22 ft. 6 in. and a total length of 504 ft.

The building was designed for overhead electric cranes of 20 tons capacity, but owing to the heavy weights dealt with in handling the parts of the large driving motor it was found necessary to remove the crane girders in the original portion of bay "A", replacing them with stronger girders sufficient to carry cranes of 35 tons capacity.

Casting and Heating Arrangements

The ingots to be rolled are cast from open-hearth furnaces in an adjacent building and conveyed hot on a transfer bogie into bay "B" by means of a 3-ton electric warping winch.

The furnaces and soaking pit embody all the latest modern improvements, as will be seen from Figure 6. This photograph gives a very good view of the reheating furnace at the discharging end. The two furnaces of this type are arranged parallel at a convenient distance from each other as shown by the photograph. They are of the gas-fired, reversing, regenerative, continuous type equipped with hydraulically operated pusher at the inlet end, each having a hearth 6 ft. 6in. wide and 50 ft. long.

The soaking pit is of the gas-fired type with gas and air reversing regeneration. The dimensions of the pit are 36 ft. 6 in. long by 6 ft. wide at the top and 5 ft. at the bottom, 5 ft. 6 in. deep and capable of holding 24 ingots. The pit is arranged with rolling lids operated by hydraulic cylinders.

The continuous furnaces are intended for heating cold ingots. In the case of some special steels it is essential to heat the ingots gradually from a cold to a rolling temperature, and for this operation the type of furnace is admirably adapted. Figure 6, already referred to, also gives a clear view of the 2-ton overhead charging machine operating in bay "B" for the conveyonce of hot ingots from the transfer bogie to the soaking pit and thence, after re-heating, to the mill.

A 4-ton low-ground type ingot charging machine extracts the hot ingots from the discharging end of the continuous furnaces, and deposits them on a stand close by from which they are picked up by the overhead charging machine and taken direct to the mill. This machine with its rail track can be seen in Figure 6.

A gravity roller track links the soaking pit with the continuous furnaces. It is equipped with an automatically operated tippler chair for the purpose of transferring, from bay B to bay A, surplus cold ingots requiring to be reheated.

The charging machine, roller track, and soaking pit were supplied by the Wellman, Smith Owen Engineering Corporation Ltd.

The Main Control Platform

The main control platform is placed on the approach side, spanning the entire width of the mill. Here are fixed the controls for the mill motor, the motors driving the ingoing and outgoing live rollers, skids and screw down gear, the hydraulic controls for the manipulators, together with the requisite electrical instruments.

A platform is also arranged between bays "B" and "C" beyond the hot saw on which are situated the controls for the motors driving the run-out to the saw and the run-out beyond; the skids at the cooling bank, the hot saw, with the hydraulic controls for the sliding carriage of the saw and the cylinder operating the lifting fingers at the tank.

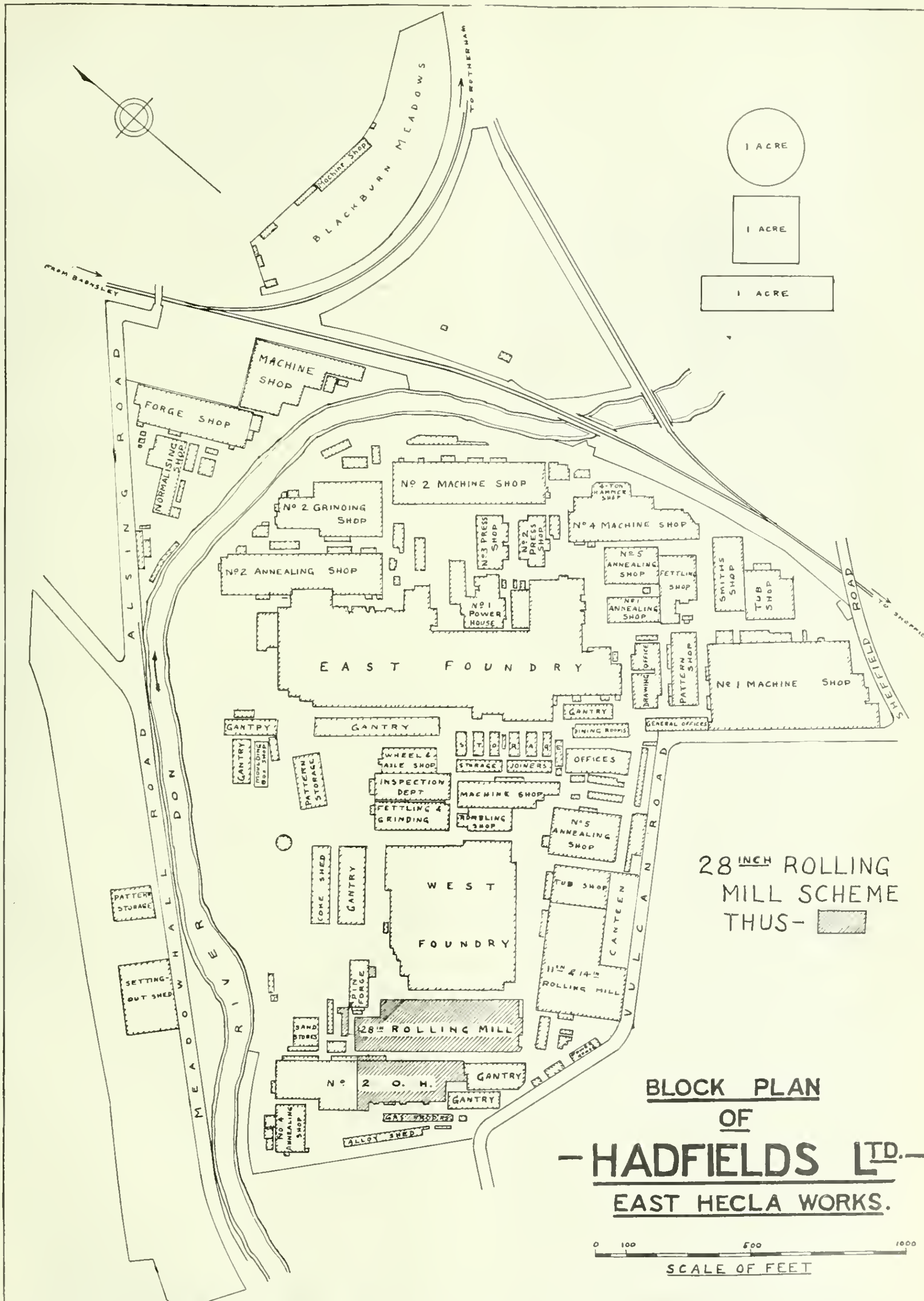
Output Capacity

The well-designed mill plant, supplied by the Brightside Foundry and Engineering Co. Ltd., Sheffield, is capable of rolling down 15 inch square steel ingots 5 ft. 0 in. long, having a weight of 25 cwts., reducing them at one heat to 2 1-2 inch square billets. The normal output will be approximately 1,500 tons per week (of 110 working hours), or say 15 tons per hour, with a maximum of 20 tons per hour for occasional, short periods. The mill will also roll Hadfield "Era" (Trade Mark) manganese steel ingots into rails up to the heaviest section in demand, having a maximum length of 55 ft. 0 in. rolled, and say 45 ft. 0 in. finished; also steels containing up to 0.8 per cent carbon.

As a result of the close co-operation between Messrs. Hadfields and the manufacturers, their large mill has been designed on very liberal lines to deal satisfactorily with steels of the special nature required, and in this respect the mill is unique for one of its size. It embodies the most modern design and construction, and is equipped with all the necessary improvements and labour-saving devices to obtain the most economical production, being in fact far in advance of the type of mill now generally used.

Stands and Rolls

Figure 8, shows the pinion housing and roughing and finishing stands.



BLOCK PLAN OF -HADFIELDS LTD.- EAST HECLA WORKS.
28 INCH ROLLING MILL SCHEME THUS-
SCALE OF FEET
1 ACRE
BLACKBURN MEADOWS
MACHINE SHOP
FORGE SHOP
NORMALISING SHOP
Nº 2 MACHINE SHOP
Nº 2 GRINDING SHOP
Nº 2 ANNEALING SHOP
Nº 3 PRESS SHOP
Nº 2 PRESS SHOP
Nº 4 MACHINE SHOP
Nº 5 ANNEALING SHOP
FETTLING SHOP
Nº 1 ANNEALING SHOP
SMITHS SHOP
TUB SHOP
Nº 1 POWER HOUSE
EAST FOUNDRY
DRAWING OFFICE
PATTERN SHOP
Nº 1 MACHINE SHOP
GENERAL OFFICES
GANTRY
DINING ROOMS
WHEEL & AXLE SHOP
STORAGE
JOINERS
OFFICES
INSPECTION DEPT
MACHINE SHOP
FETTLING & GRINDING
PATTERN STORAGE
MOULDING BOX SHOP
WEST FOUNDRY
CORE SHED
TUB SHOP
CANTEEN
11IN & 14IN ROLLING MILL
SETTING-OUT SHED
28IN ROLLING MILL
SAND STORES
Nº 2 O. H.
Nº 4 ANNEALING SHOP
ALLOY SHED
GAS PRODUCERS
RIVER DON
MEADOW HALL ROAD
ALSING ROAD
VULCAN ROAD
SHEFFIELD ROAD
FROM BARNSLEY
TO ROTHERHAM
TO SHEFFIELD

Fig. 4

The cogging rolls are 28 in. diameter by 7 ft 0 in. long, and the finishing rolls, 28 in. diameter by 6 ft. 6 in. long.

The Electric Motor

The motor is connected to the bottom pinion by a coupling of the well known "Ortman" sliding type, constructed entirely of steel, the engaging portions of which are renewable. It can be engaged or disengaged by hydraulic gears enabling the motor to be run independently of the mill for testing or other purposes.

Pinions: The pinions are of high grade carbon forged steel, having machine-cut double helical teeth 32 in. diameter, 42 in. face, fitted with replaceable wobblers and mounted in a totally enclosed cast-iron housing of robust construction, fitted with anti-friction metal lined bearings. The teeth of the pinions are lubricated as near the point of contact as possible by specially arranged trays or spreaders, and the oil for the pinions and bearings is kept in continual circulation by means of a motor-driven rotary pump.

*Spindles:*The spindles between the pinions and the cogging rolls and between the latter and the finishing rolls are of forged steel having machined fluted ends, the top spindles being of the "Universal" type fitted with renewable phosphor-bronze wearing blocks and properly balanced with cast iron weights, while the bottom spindles are supported in stationary bearings on springs. The ends of the spindles and the inside of the wobbler boxes are machined with a minimum of clearance to eliminate blacklash as much as possible.

Housing: The housings for the cogging ond finishing stands are of solid steel construction, machined throughout on all fitting faces, and fitted with cast steel chocks and forged steel renewable wearing plates, with provision for end adjustment.

The main rolls were manufactured throughout by Messrs. Hadfields Ltd. and are of their special quality high grade carbon forged steel with machined fluted wobbler ends.

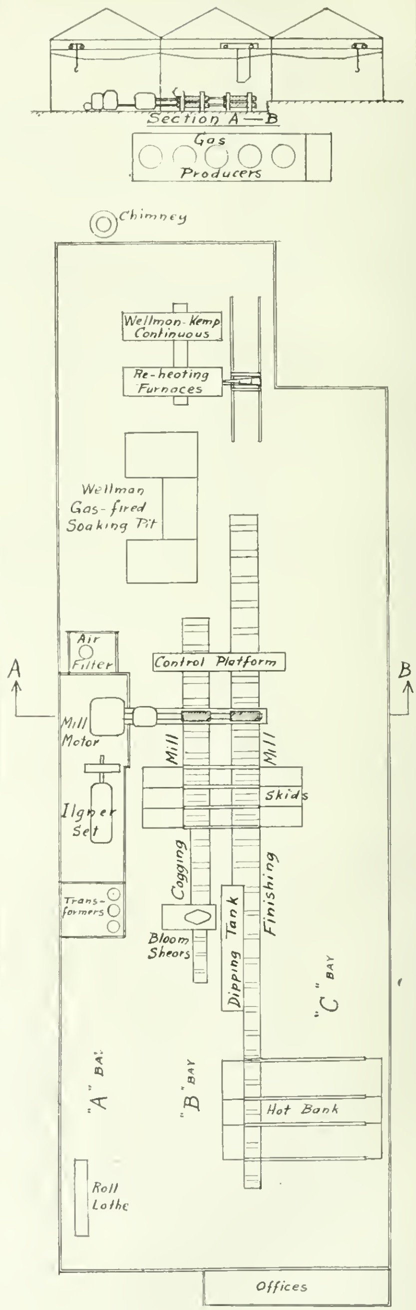
The upper roll of the cogging mill is arranged for ample lift, and is also hydraulically balanced, being raised or lowered by means of a totally enclosed worm reduction screw-down gear, the power being supplied from a 40 H. P. motor. A safety slipping device pro-anced and arranged with hand screw-down gear.

Hadfields "Home-Made" Rolls

The upper roll of the finishing mill is spring baltects the motor from exceptional overloads.

Bed Frame: The cogging and finishing housings, together with the pinion housing, are mounted on a massive cast iron bed frame the section under the roll housings having an inverted V type of face while that under the pinion housing has a flat face. The bed frame is machined on the face and on the feet of the housings at the fitting points, ensuring perfect rigidity.

Live Roller Gear: The live roller gear for the cogging mill is arranged with a cast iron frame of heavy design, the driving side of which is in the form of a trough with both roller and line shaft bearings formed in one piece, while for the finishing mill, having the rollers at a greater distance apart, a mild steel framing is provided on which separate enclosed gear cases are mounted for each pair of mitre wheels.



GENERAL ARRANGEMENT
28-INCH REVERSING ROLLING MILL

0 50 100
Scale of feet

Fig. 5

All gear boxes are provided with dust-proof covers, and, in all cases, the bearings are of the ring oiling type, and the mitre wheels of cast steel.

All live rollers are turned on the barrels, and are of cast iron, with the exception of the first four rollers on either side of the main cogging rolls and the first two rollers at the approach end of the ingoing side, which are of cast steel.

The live rollers are driven by 40 H. P. motors through the medium of totally enclosed machine-cut reduction gears, having ring oiling bearings, the whole being designed on high-class lines.

Powerful Bloom Shearing Plant

The Hydraulic Shears are of the up-cutting type complete with hydraulic intensifier arranged for a maximum power of 1,000 tons and capable of shearing "Era" (Trade Mark) Manganese Steel blooms when hot up to 10 inches square. The main castings are all steel with the exception of the base, which is of iron, and the shears are arranged for working at a pressure of either 1 ton per square inch without the intensifier or 2 1-4 tons per square inch with the intensifier. The main ram is 24 inches diameter and suitable provision is made for varying the gap between the knives to suit the size of bloom being cut, thus saving useless travel of the main ram.

Intensifier: The Intensifier is constructed of steel throughout and is of the telescopic type having differential rams 8 inches and 12 inches diameter, with a maximum stroke of 7 feet, which gives 9 inches travel of the shear blades under intensified pressure.

Hot Saw: The Hot Saw is of the horizontal sliding type arranged with a blade of 60 inches diameter, and driven by a 75 H. P. motor by means of two belts from pulleys mounted on an extension to the motor shaft. The saw spindle and motor are mounted on one carriage, which slides forwards and backwards, operated by power from a hydraulic cylinder. Provision is made for readily changing the saw blades without removing the spindle from its bearings.

Skids: The Skids are arranged with wire ropes passing round spiral drums at the driving end and single grooved pulleys at the opposite end, provided with tension screws and springs to take up the slack in the ropes.

Rails with suitable stools for carrying them are provided, on which the skid carriage travels to and fro; in the case of the skid gear between the cogging and the finishing mills the skid is clipped to the rope and slides on the rails, whereas the skids at the cooling bank are in the form of a carriage to either end of which is attached the rope; the carriage is provided with wheels to run on rails, the skids being of a balanced type free to fall over when passing underneath the bar lying on the live rollers, and recover an upright position at the proper time to push the bar forward.

Spiral Drums: The spiral drums are attached to a long shaft which is driven by a 40 H. P. motor, with totally enclosed reduction gears of the same type as those driving the live rollers.

Motor Maximum Of 11,600 *H. P.*

The mill motor, built by the British Thomson-Houston Co. Ltd., which has an R. M. S. rating of 3,200 H. P. and a maximum rating of 11,600 H. P. is capable of exerting a constant torque of 125 tons-feet from standstill to 60 revolutions per minute in either direction, and gives a constant horse power of 3,200 H. P. between the speeds of 60 and 120 revolutions per minute. The overload capacity corresponds to a torque of 453 tons-feet between standstill and 60 revolutions per minute; and 11,600 H. P. between the speeds of 60 and 120 revolutions per minute. Figure 9, illustrates the motor looking at the driving end.

The motor, which is of the double armature type, is shunt wound, with compensating windings in the

Fig. 6 — Soaking Pit, Continuous Furnaces and Chargers

pole faces, and is provided with commutating poles, the two armatures being connected in series for a maximum voltage of 1,300 V. Ventilating air for the motor is cooled and cleaned by first passing through a wet air filter of the "Invincible" type, capable of dealing with 25,000 cubic feet of the air per minute.

A 30 Ton Flywheel

Power is supplied to the mill motor from a Flywheel Motor-Generator, an induction motor of 1,800 H. P. running at 600 r. p. m. (synchronous speed) on a pressure of 3300 V. coupled direct to two shunt wound compensated generators each rated at 1300/4750 K. W. when running at 500/600 r. p. m. at 650 V. The shaft extension of the outer generator is fitted with a buffer spring type flexible coupling, connected with a cast steel fly-wheel of 11 ft. 6 in. diameter and 30 tons in weight.

The cast steel flywheel, which was made by Messrs. Hadfields Ltd. is of the built-up type, two heavy rings forming the rim, being spigotted and securely held by through rivets to the central boss and disc wheel portion, the rivet heads being countersunk, rivetted, and turned so that no projections are left. A water cooled brake is provided to bring the flywheel quickly to rest in case of emergency.

The speed of the flywheel is indicated on two instruments, one located on the main instrument board and the other on the control platform.

Mill Motor and Generator Fields

The mill motor and generator fields are supplied from a three-unit exciter set which comprises a D. C. motor, mill motor exciter and generator exciter. The field windings of these exciters are designed to give rapid control of the mill motor, and since all speed variation is obtained by control of exciter fields, only small currents have to be handled, a Ward-Leonard controller mounted on the control platform being used for this purpose.

Power For Emergency Needs

The power for driving the mill is taken from the Sheffield Corporation mains at 11,200 V. 50 cycles, 3 phase, and transformed by static transformers to 3300 V. The supply to the induction motor is controlled by switch-gear of the Ironclad drawout truck type, starting and speed being controlled by a special contactor starting and slip regulating panel, which makes the starting operation entirely automatic.

Although well known to most engineers, it may be interesting to our readers to know the principle on which the sudden demand, so to speak, of 12,000 horse power, which may occasionally be wanted in connection with the working of this Mill, is met, especially as in this case the power is obtained from the power station of the Sheffield Corporation.

It is to supply the large emergency demand for power that the flywheel set is interposed between the power lines of the Sheffield Corporation and the main mill motor. As described above, this set consists of one 1,800 horsepower, three phase motor, and, on the same shaft, two dynamos of, roughly speaking, 6,000 H. P. and further along the shaft, a 30-ton flywheel. The three-phase motor is mainly used to start up the flywheel set, and of course it will drive the main mill motor up to the limit of its rating of 1,800 horsepower. Any further resistance against the main mill motor is met by power supplied by the generators on the flywheel set, this power being developed by the action of the flywheel. By slowing down slightly under load, the flywheel releases energy to the two 6,000 horsepower generators, which in turn pass this released energy along to the main mill motor in the form of electric current. Hence the maximum power demanded from the Sheffield Corporation should not exceed 1,800 to 2,000 horsepower and this only when the flywheel set is required to do more than ordinary running. Although the maximum power of the main motor is

Fig. 7 Ro

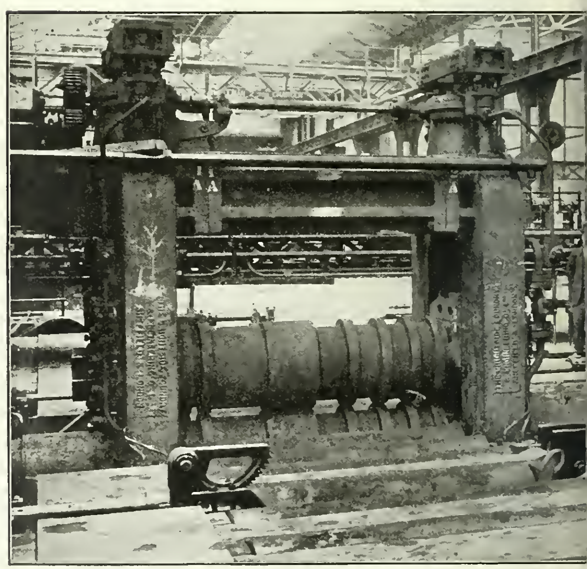
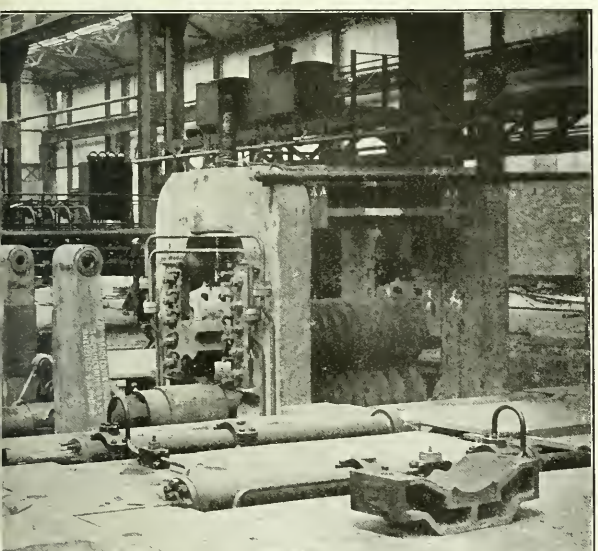


Fig. 8 — Pinion Housings, a

Mill Shop



Roughing and Finishing Stands

given by the builders as about 12,000 horsepower, it is doubtful whether this maximum figure will ever be required. The ordinary normal power of the main mill motor is 3,200 horsepower, which may run up to 4,000 or 5,000. The heavier amount of power is put into the main mill motor on account of the reversing and accelerating needs, the main motor being capable of being reversed from full speed in one direction to full speed in the other direction in three or four seconds.

The Ward-Leonard controller and main instrument desk equipped with a main ammeter for reading the current input to the mill motor, with two speed indicators, for the mill motor and flywheel set respectively, are all fixed on the main control platform.

Details Of Mill, Capacity, etc

The general character of the 28 inch mill with its capacity may be conveniently tabulated as follows:

No. of stands—Two i. e., 1 cogging and 1 finishing.

Size of rolls—Cogging—28" dia. x 7' long.
Finishing—28" dia. x 6' 6" long.

Maximum size of ingot—15" square at large end, 13 1-2" square at small end, 4' 6" to 5' long. Weight 25 cwts.

Minimum size of ingot—9" square, 4' long.

Capacity of Mill—(a) To roll Hadfield Steel Ingot 15" square down at one heat to billets 2 1-2" square.
(b) To be capable of rolling the Hadfield High Carbon and Special Alloy Steels.
(c) To roll the Hadfield "ERA" (Trade Mark) Manganese Steel Ingots 13" square into billets, rails, etc.

Average output—1,500 tons per week of 110 working hours of 2 1-2" square steel billets, or say 15 tons per hour.

Maximum output—20 tons per hour of 2 1-2" square steel billets for occasional short periods.

Products dealt with—Of Mill and Special Steels.
(a) Ranging from 8" to 2 1-2" billets in finishing stand.
(b) Ranging from 8" to 5" billets in cogging stand.
(c) Irregular sections as required.
(d) Manganese Rails up to the heaviest section in demand, and a maximum length of 55 ft. rolled, say 45 ft. finished.
(e) Blooms of any size within the range of ingot.

Length of Billets—Any length required to suit ingot.

The grand total weight of the mill is about 1,600 tons, including the following principal items.

Approximate weight of mill	1,100 tons
Approximate weight of electrical equipment	400 tons
Weight of flywheel on Motor Generator set	30 tons

Area of Shop. Original shop: 49,608 square feet.
Portion added: 26,730

76,330 or 1.75 acres.

The complete plant comprises: Buildings, mill including foundations and erection; main mill motor; Ilgner flywheel set exciter; switch gear; live roller gear motors; two re-heating furnaces, 50 feet long; soaking pits; two-ton overhead charger; four-ton ground charger; one 20-ton crane; two 35-ton cranes; roll turning lathe; hydraulic pumps; motor, accumulator; hydraulic services; toughening tank, tippler gear; eight 28 inch rolls, and incidentals.

The general Layout Of The 28" Mill

The various illustrations will assist in giving an idea of the general lay-out. The mill comprises a

roughing and finishing stand in direct line with the main driving motor, the pinion housing being situated between the motor and the roughing stand. The ingots are conveyed to the roughing mill by live rollers. At the approach end of the ingoing live rollers is an automatically operated tilting chair in which the ingots are deposited by the overhead charging machine. On the outgoing side of the roughing mill is a run-out to the bloom shears, with a short length of roller track extending beyond, for the removal of the cut blooms, etc. Skid gear is arranged for transferring bars from the roughing to the finishing mill, and on the outgoing side of the latter is a run-out to the hot saw, also a run-out beyond the saw with skid gear and cooling bank, into bay "C".

The necessary appliances for carrying out the requisite treatment on the Hadfield "Era" (Trade Mark) Manganese Steel Rails are arranged at the side of the ingoing run-out by which the rolled material is conveyed to the saw. This treatment is carried out in accordance with the firm's patents, in order to ensure the full and wonderful toughness of this product. The live rollers are provided with manipulating devices operated from the bridge. By this means the rail is carried away for the necessary quenching operations, which give the manganese steel its remarkable toughness and resiliency.

On both sides of the roughing and finishing stands are hydraulically operated manipulators of the "Wiliams" type. They are specially adopted because of the ease with which they manipulate the bars and billets during the process of rolling, eliminating all man handling.

A switch giving remote control of the main circuit breakers, also indicating lamps showing the operation of the circuit breakers, is also provided on the control desk.

Auxiliary Motors

The auxiliary motors for driving the live rollers, skids and screw down gear on cogging rolls, of which there are eleven in number, are all 40 H. P., running at 500 r. p. m., of the reversing steel works type, totally enclosed, series wound with commmutating poles. These motors are rated on a basis of one hour's duty for mill work, and will carry 100% overload without sparking, and can also be run at still greater overloads without serious effect from sparking.

The motors are all arranged for remote control by means of "Ironclad" totally enclosed reversing master controllers and control panels of the contactor type, with separate specially rated protected grid type resistances, located at the most convenient points.

The master controllers for the motors driving the ingoing and outgoing live rollers of the cogging and finishing mills, also the screw-down gear for the cogging mill, and the skids between the cogging and finishing mills, are all situated on the main control platform; whereas, for the run-out live rollers to the hot saw and beyond, also the hot saw and the skids at the cooling bank, the controllers are fixed on the separate platform previously referred to.

Engine House And Mill Signals

A noteworthy feature of interest is an electric telegraph system established between the control platform and the electric equipment house by which orders may be communicated between the mill driver on the platform and the attendant in the electrical equipment house, and vice-versa. There are two instruments at either end of the system, i. e., a transmitter and an indicator, and when an order is transmitted at one end a Klaxon horn sounds at the opposite end until the order is acknowledge by moving a handle on the indicator to the corresponding order, when it cuts out the horn and leaves a light glowing showing the order given. This system must prove extremely useful in case of accident, breakdown or sudden and unexpected happenings either in the mill or enginehouse, facilitating instantaneous action, when called for. The instruments for this system were supplied by Messrs. Mechans Ltd. of Glasgow.

Gas Producing Plant

The gas for the continuous furnaces and soaking pit is supplied by five Gas Producers. These producers are 8 ft. 6 in. diameter inside the lining and each is designed to gasify 10 cwts. of coal per hour.

Coal for the producers is discharged from railway trucks underneath, whence it discharges into a gravity bucket elevator and conveyor. The latter deposits the material in hoppers above the producers.

The gas is conveyed to the furnaces and soaking pit in underground brick flues, and the waste gases travel to the chimney, which is 5 ft. 9 in. diameter inside the lining and 120 ft. 0 in. high.

The necessary steam for the gasification of the coal is supplied by a Loco Multitubular Boiler.

Hydraulic Water Service

The Hydraulic Water Service to the mill is arranged for a working pressure of 1 ton per square inch, and is supplied by a set of three-throw pumps having 3 3-4 in. diameter rams, 15 in. stroke, and driven by a 175 H. P. motor running at 375 r. p. m. through the medium of totally enclosed machine-cut double helical reduction gear. These pumps deliver to an accumulator having an 18 in. diameter ram and 20 ft. 0 in. maximum stroke, the pressure water from the latter being delivered by a 2 1-2 in. diameter steel main to the mill, and the return water from the mill by a 4 in. diameter wrought iron main.

The starting panel for the pump motor is of the enclosed contactor type, controlled by a tappet switch actuated by the rise and fall of the accumulator; the latter also works a pilot valve which operates a byepass and non-return valve on the pumps, enabling them to be started up unloaded.

The pumps are housed in a brick building a short distance from the mill, provided with a hand overhead travelling crane for handling the machinery.

Staff And Roll-Turning Requirements

In regard to Staff and other requirements for the working of the mill, it may be added that the shop is complete with offices for the accommodation of the mill manager and clerks, and proper provision is made for turning the main rolls for the mill in bay "A," where it will be noticed is a roll turning lathe, etc. with ample space for the storage of rolls.

Finish Of Floor Of Mill

In concluding the description of the rolling mill plant, reference may be made to the neat manner in which the floor surrounding the mill is finished off, all the live roller gear, which at the finishing mill has a length of 320 ft. 0 in. being below the floor and the latter presenting an even, plated surface, with the exception of the live rollers which necessarily project slightly above the floor level.

This mill, in addition to supplying other requirements, will also act as a feeder to the two smaller

rolling mills, 1 in. and 14 in. (Figure 10) already referred to.

Weight Of Mill

The total weight of the mill is about 1,600 tons, a large proportion of which is steel.

Credit Due To Directors

The credit for this important addition to the steel producing and rolling mill capacities of Messrs. Hadfields, Ltd., is largely due to the foresight of the Chairman, Sir Robert Hadfield, Bart., F. R. S., etc., Mr. P. B. Brown, M. Inst. C. E., Managing Director; Major A. B. Clerke, C. B. E., Late R. A., Managing Director; Mr. J. P. Crosbie, Director; Mr. James Crosbie, Works Engineer, who has superintended the designing and erection of the plant; Mr. I. B. Milne, Director, and Mr. W. J. Dawson, Director. Mr. A. M. Jack, M. Inst. C. E. who has recently retired from the Board, largely assisted in the development of these works.

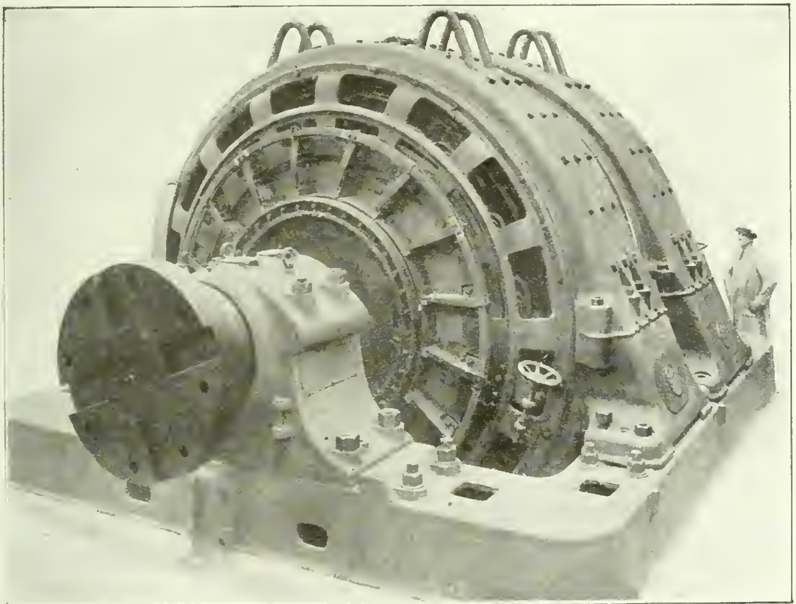


Fig. 9
Mill Motor 3200 to 11,600 H. P.

SECTION VI
11" AND 14" ROLLING MILLS

These mills are of the continuous running, bar type, each driven direct by an electric motor having a fly wheel and flexible coupling interposed between the motor and the mill. The mills are complete with the usual reeling machines, shears and hot saws, etc., all driven by individual electric motors, each machine being situated in the best possible position for handling the material in the progressive stages after leaving the rolls. A roll turning department is provided in which are electrically driven rolls turning lathes and the full equipment for turning rolls.

The furnaces for heating the billets before entering the rolls are of a patent semi-gas recuperative design and have been proved to be capable of heating up the billets in the shortest possible time with a minimum of fuel consumption.

The whole equipment is laid out on the most modern lines and is excellently arranged for obtaining the maximum of production with a minimum of labour. Overhead electric travelling cranes assist in handling the raw and finished materials, also changing rolls, etc., and a conspicuous feature of the plant is the lofty, well lighted and well ventilated building, which at the same time provides an abundance of floor space which is so essential to the successful operation of rolling mills.

The mills are essentially for the production of high carbon and special alloy steels, also of the Hadfield "Era" Manganese Steel. They are specially designed, of an exceptionally robust character to withstand the abnormal stresses arising from the rolling of steels of this description. It is a noteworthy feature that for mills of their sizes they stand out alone in their capacity for dealing with high outputs of specially high quality hard steel as compared with other mills of the same sizes.

The main features of the two rolling mills are as follows:—

11" *Rolling Mill*

Arrangements—This is arranged with five sets of housings, i. e., one three-high and four two-high, driven by a 400 to 800 H.P. compared compole motor having a rated speed of 150 to 250 r.p.m., through the medium of a totally enclosed machine cut double helical reduction gear to reduce the speed of the mill to a minimum of 100 r.p.m. Interposed between the reduction gear and the motor is a flywheel of Hadfield cast steel, 10 ft. dia.having a weight of 17 tons. A buffer-spring type flexible coupling connects the motors shaft to the

flywheel shaft and a concentric type of coupling connects the flywheel shaft to the reduction gear. The starting panel for the motor is of the contractor type.
Capacity:—To roll 2½'' billets to rounds of from 1¼'' to 1½ dia. and to squares of from 1¼'' to 1'' side, also to flats of equivalent section within the capacity of the mill and other special sections as required.
Output:—According to product required.

14'' *Rolling Mill*

Arrangement:—This is arranged with six sets of housings, two-high, driven by a 500 to 1000 H.P. compound compole motor having a rated speed of 75 to 150 r.p.m. the rolls running at the same speeds. Interposed between the mill and motor is a cast iron flywheel of 12'0'' dia. having a weight of 40 tons. A buffer-spring type flexible coupling connects the motor shaft to the flywheel shaft. The starting panel for the motor is of the contractor type.
Capacity:—To roll 5'' billets to rounds of from 3'' to 1'' dia. and to squares of from 3'' to 1'' side, also to flats from 7'' to 1'' down and other special sections as required.
Output:—According to product required.

The whole of the steel castings and forgings used in these mills are of the Hadfield best cast steel.

SECTION V I I
HADFIELDS WORK DURING THE WAR INCLUDING THE PRODUCTION OF ARMAMENT MATERIAL

The world now realises that the winning of the Great War was immensely helped on by the assistance rendered in the factories of Great Britain. In this good work Messrs. Hadfields took their full share, as might have been expected in view of their special facilities for a large output or war material.

Plant Extensions

The shortage of weapons and ammunition in the earlier stages of the war necessitated the building of additional shops and the introduction of large quantities of heavy machinery, and, during the first year, it was found possible to quadruple the output of large armour piercing shells, that is, 13.5'', 14'', 15'' and 16'', while furnishing large supplies of shells of smaller calibre, 12'' and under, for Naval purposes.

An entirely new plant was laid down at great cost for the production of two hundred 15-inch high-explosive shells per week, five hundred 6-inch semi-armour-piercing shells, with other machinery enabling a weekly output to be made of 10,000 Naval shells. Developments were practically continuous, and before the end of the war the largest armour-piercing shell in the world, weighing 1½ tons, was turned out in large numbers, capable of piercing hard-faced armour 16 inches in thickness at a range of 15 miles. The grand total of armour-piercing projectiles, chiefly of calibre ranging from 12 inch to 15 and 18 inch, and high explosive shell supplied by Hadfields to the British Government totalled 3,500,000.

Prior to March 1917 the firm had not made any guns or howitzers, yet before the end of the war they had turned out 250 complete howitzer guns up to 8 inch calibre, 3,000 gun tubes up to 9.2'' calibre, 3,400 trench howitzers of 6-inch calibre, 700 repaired guns up to 3-inch calibre, in addition to many thousands of other gun parts.

Helmets

The introduction of helmets made of the Hadfield "Resista" steel is estimated to have saved tens of thousands of lives and numberless severe wounds. This steel was invented by Sir Robert Hadfield, and no fewer than six million helmets were produced, utilising 4,000 tons of "Resista" steel. Just before the war ended, the French authorities were negotiating for the supply of

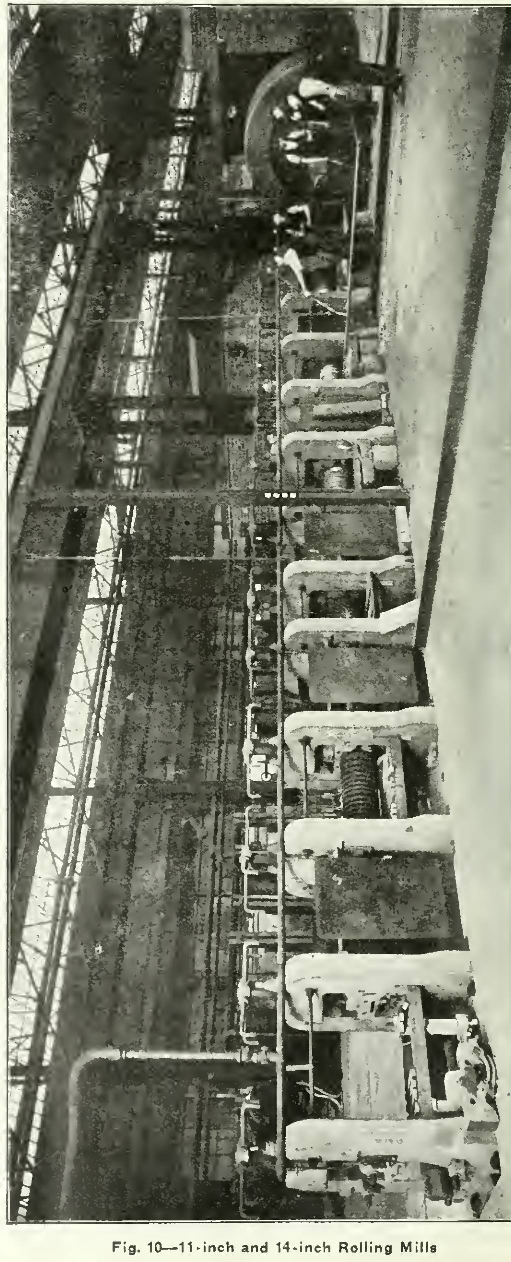


Fig. 10—11-inch and 14-inch Rolling Mills

helmets for the French army, and arrangements were made to supply 50,000 in two days; almost immediately afterwards the armistice was concluded. Great regret has been expressed that the helmets were not more extensively adopted at a much earlier stage of the war, when the French army would without doubt have saved many thousands of lives and avoided many thousands of severely wounded soldiers.

Hadfields took their share in the building and equipment of tanks, furnishing 48,000 bullet-proof plates, 125,000 links, 20,000 gear wheels and pinions in manganese steel, while about 3,000 tons of their "Era" steel was supplied for various aeroplane requirements.

The total value of war products supplied by the firm was no less than £36,000,000.

In connection with guns, great economy was effected by the employment of the Hadfield Sound Steel System, which reduces the waste or discard to something like 15 or 20% instead of 50 to 60% by the ordinary methods. There was a marked saving in time and labour effected by the adoption of the system of piercing and extrusion, enabling the howitzer to be made direct from the billet without preliminary rolling or forging of any kind. It was considered a new idea to produce guns direct from castings; although doubst were expressed at the time as to its possibility, the system proved a triumphant success, thereby saving very large sums for the British Government and increasing the rate of output to a most remarkable and unexpected degree.

Electrical Energy Consumed

It is interesting to know that during 1917, when an immense output had been obtained at the Hadfield works for munition purposes, the grand total of electrical energy used was 54,750,000 units, half of it in electric furnaces at the East Hecla Works, where over 100,000 tons of steel were melted, much of which would otherwise have been wasted.

Steel Production

Nearly the whole of the steel used in the production of war material was manufactured from the raw product as it left the blast furnace, into a completely finished product at the Hadfield Works. The steel produced was sufficient to make a bar, two inches in diameter, long enough to encircle the earth at its equatorial circumference.

Vertical And Horizontal Presses

Hadfields were equipped during the war with more heavy hydraulic shell presses than any other maker. This was a definite advantage which enabled the British Government to obtain considerable qantities of armour-piercing shell up to the largest calibre, 18 inches, not only at reasonable prices, but with extraordinary rapidity. Three of these large presses, had capacities up to 2,500 tons pressure. They were splendid tools for the work required, being massive, strong and easily worked.

In addition to these three large presses, Hadfields also had in operation one 450-ton and one 1,000-ton horizontal press. As regards vertical presses, they had three 113-ton, three 314-ton, two 4550-ton, and six 800 tons capacity.

With regard to heavy hydraulic forging presses for ingots and general forging work, Hadfields have erected new and complete establishments, including steel plant and presses, equipped with one 1,000-ton press and two 1,500-ton vertical presses, now in use for peace time purposes.

It may be added that the Hadfield cast and forged steels were largely used in the construction of these presses.

WORLD'S OUTPUT OF ELECTRIC STEEL.*

Except in two or three countries practically no electric steel was made prior to 1913. In the United States, Germany and France, particularly the latter two, electric furnaces were making steel as early as 1908 and 1909. The industry, however, did not attain any magnitude until 1913. In that year Germany was its acknowledged leader.

Due to the stimulus of the war, the electric steel industry of all producing countries expanded until the peak was reached in 1918, when over 1,140,000 tons was produced against only 168,600 tons in 1913. In this period, however, the United States gradually displaced Germany from the lead, with an output in 1918 nearly equal to that of the seven other producing countries combined. The output in 1915 was about 80 per cent. greater than in 1913, while in 1916 it was about 90 per cent. greater than in 1915. From 1916 to 1917 the increase was about 50 per cent., and from 1917 to 1918 the expansion was about 40 per cent.

In 1913 Germany produced over 50 per cent. of all the electric steel then made. Although the United States ranked second in that year, the industry had only just started. Germany and Austria-Hungary were credited with close to 70 per cent. of the world's output in 1913. But by 1918, although Germany had increased its electric furnace production about 2½ times, the United States output had expanded 17 fold. Their output was not only twice that of the two so-called Central Powers, but was nearly half the total of all the producing countries. Another feature of the development of this industry up to 1919 was the rapid growth of the British and Canadian production. In 1913 there is no record of any output in those countries, but in the four years 1915 to 1918 inclusive, the British electric-steel industry had expanded five fold and the Canadian about 21 fold.

The progress of the industry as a whole in the readjustment period since the war, or in 1919, 1920 and 1921, has varied with the peculiar conditions existing in each country. Despite the falling off, the 1919 total for six countries was larger than the 1916 total for eight nations. The 1920 total for six countries, assuming Germany to have made as much as in 1919, exceeds the 1917 output for eight. In 1921, the year of world-wide depression and strikes, probably over 425,000 tons was produced by the six countries, including Germany, or a figure nearly equal to the output of 1913 and 1915 combined. The following table excludes any post-war returns from Germany and Austria, figures not being available:

Output of Electric Steel Ingots and Castings in the Leading Countries in Tons

Country	1913	1920	1921
United States	30,180	502,152	169,499
Germany	88,256	....	....
Great Britain . . .	None	89,100	27,100
Canada	None	28,301	16,844
Austria-Hungary . . .	26,837	....	....
France	21,124	58,080	24,457
Italy	.....	*100,000	*140,000
Sweden	2,276	....	....
Total	168,673	777,633	377,900

* Estimated.

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*Iron and Coal Trades Review.

The Metallurgy of Semi-Steel*

BY DAVID McLAIN

The author may be thought to be presumptuous and egotistical in daring as an American to address Britishers on the science of melting iron and steel or wrought scrap in cupolas, as some have been doing it very successfully for years, but please remember there is no more electricity in the world to-day than there was years ago, and until someone recognised the law by which it could be made of service, we knew but little of it. Today the world is lit up by it. Just so as with the laws governing the science of melting steel scrap in cupolas, it took someone to prove that (1) steel scrap will *not* reduce total carbon; (2) steel scrap will *not* cause hard spots; (3) manganese is *not* a hardener; (4) high blast is *not* required; and although the author demonstrated all this twenty or more years ago, many writers to-day still claim steel will reduce carbon, and that is the main reason for the author's presence in Great Britain.

Writers for technical papers have advised foundrymen that it is necessary to use cold-blast pig, hematite pig, cerium, titanium, vanadium and other alloys if they want to make quality castings.

Others have also been advised to melt iron in the electric furnace, the air furnace, and the open-hearth furnace, and that quality iron, semi-steel and steel can be made in the electric furnace from cheap borings and turnings, but the cupola, in the hands of competent operators, can produce quality metal using steel and wought scrap and other materials.

The cupola is considered a mysterious piece of equipment by many, who compare it to a bucking horse. They pose as authorities, but they "let George do it," and if the metal is good they take the credit, but if it is of poor quality they blame George for it.

Potentialities of Semi-Steel

We believe this subject should be discussed to a satisfactory conclusion, as engineers and foundrymen throughout the world are guided by writers who should know that good semi-steel of ½ in. section is stronger and will resist hydraulic tests better than the average grey iron of 1-in. section.

Initially it may be as well to submit a few facts concerning the absorption of carbon by the steel from coke. When a boy the author learned that steel absorbed carbon from a facing sand containing coke. Open-hearth steel of 0.20 to 0.30 per cent. carbon poured in gear blanks made of this facing were considerably higher in carbon on the exterior than the interior.

Taking advantage of this knowledge, the writer made tramcar wheels, using this coke facing on the tread, and after outwearing several sets of grey iron wheels, a large order was placed for similar wheels, being designated on the specifications as "chilled steel wheels." A steel rod in a blacksmith's fire showed signs of melting one day, and investigation proved that that rod had been in the fire frequently, absorbing carbon each time, until eventually the melting point was lowered to that of grey iron.

The ancients learned that a lump of iron ore thrown on an open fire, heated to redness and hammered, would develop into a spongy mass of iron that could be hammered to form implements of war, and modern chemists have analysed swords made by the ancients, finding there was 1 to 2 per cent. carbon present, this proving conclusively that wrought iron or steel will absorb carbon when heated in the presence of a carbonaceous fuel, so the writer experimented with coke and steel scrap in cupola mixtures, and was agreeably surprised to learn that steel will absorb up to 3 to 5 per cent. carbon, depending on the melting conditions. Synthetic pig-iron would be impossible except that the steel turnings absorb carbon from the coke.

Making semi-steel, like other things, depends on knowing how. Take Hadfield's process of producing manganese steel. Without his formula and instructions, the "man in the street" could not make it. The author has met many who tried to make manganese steel, but failed in the attempt. Should manganese steel be condemned on that account? Similar conditions exist with semi-steel. Some people try to make it without the proper instructions, and the resultant metal being full of hard spots or blow holes, they condemn semi-steel. One converter steelfounder may make good steel using 60 to 90 per cent. steel scrap, because he knows how to melt it and control the sulphur, while his competitor may use 50 per cent. pig-iron and still be unable to meet the specifications.

Rapid Advance in Metallurgy

For 50 years previous to the time it was discovered that carbon is absorbed from coke when making semi-steel, very little progress was reported by grey iron foundrymen.

The greatest developments in grey iron foundry practice are traceable to the introduction of steel scrap in cupola mixtures and commonsense methods of mixing and melting: in fact, to one like the author, who has been on the firing line for approximately half a century, it appears as if there has been 100 years' advancement within the past quarter century.

False Claims.—Many text-books, whether by technical or practical men, have maintained that steel reduces carbon. Chemists and metallurgists and practical foundrymen have at times agreed that (1) steel causes hard spots, (2) will not mix with iron, (3) is not a good thing to use, (4) requires a higher melting temperature, and that (5) manganese is a hardener. The use of steel in cupola mixtures was questioned on all sides, but we learned that carbon will be absorbed from fuel by the steel up to the saturation point, and that manganese above a certain point aids in increasing the saturation point of iron for carbon.

The author has had hundreds of analyses made of both grey iron and semi-steel compared with grey iron, but there is not sufficient evidence to substantiate the claim that steel will reduce carbon.

Carbon Acts as a Medium

As carbon acts as a medium through which the other elements work, we do not try to remove it from iron, but learn to regulate it by studying the effects produced by silicon, sulphur, phosphorus and manganese. Study the effect of high and low blast on the carbons, and use

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*The above article, kindly provided by Mr. McLain for "Iron and Steel of Canada," has already appeared in "The Foundry Trade Journal", of London. It is of such interest that we are pleased to publish it for the benefit of our readers.

this knowledge to advantage when calculating mixtures for different castings that require softness, strength, fluidity or chill.

In melting iron in the cupola, carbon will be absorbed from the fuel when a mild blast is used, and the amount absorbed will depend on the amount of carbon in fuel, the power of material to absord carbon, and the temperature at which iron is melted.

This point alone should enable the student to realise the importance of becoming thoroughly alive to cupola operation. When poor coke and high blast are used carbon is lost, and as the total carbon is lowered combined carbon increases in proportion to this loss.

When melting steel for cupola mixtures, high-carbon coke is used for fuel. Coke, of course, can also be used in crucible melting, but in this practice the metal does not come in contact with fuel, therefore does not absorb carbon from it. On the other hand, steel melted in the cupola comes in intimate contact with the fuel, and owing to the very low percentage of the different elements in the steel, it has a strong affinity for them, particularly carbon.

When steel is heated to redness it begins to absorb carbon from the coke, and will continue until they both become incandescent, when the carbon may be 5 per cent.; consequently, it automatically increases the temperature of the melting zone above that of the highest temperature necessary to melt grey iron, and blends with the balance of the mixture.

While it is claimed that the carbons are the predominating elements in iron castings, it is impossible to produce chill castings with high silicon, say, 2.75 per cent.; in fact, the skilful metallurgist insists that silicon be 2.00 per cent. or less to produce a very thin chill, known as a "skin" chill on light castings.

The results of thousands of tests, both physical and chemical, lead one to believe that silicon is the controlling element, although sulphur, phosphorus and manganese play their parts along with the length of time the casting is allowed to cool in mould—all of which have a decided influenc on the ultimate proportions of either graphite or combined carbon.

Keep and other claimed that the carbon in liquid cast iron is all in the combined form, but this, as well as the claim that steel scrap, when added to cupola metal, will reduce carbon, did not appeal to the author.

Condition of Carbon in Liquid Cast Iron

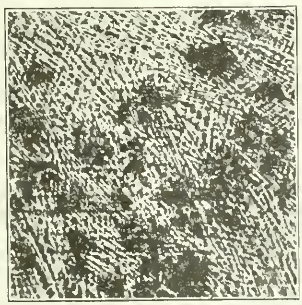
Keep claimed that graphitic carbon is only precipitated from the combined carbon by slow cooling, but the author has poured castings 1-16 to 1/8 in. thick of 2.75 per cent. silicon iron, when the metal sets or freezes almost instantly. If carbon in liquid iron is all combined, one could hardly expect a precipitation of the graphitic carbon instantaneously, but analyses proved that the carbon was practically all in the graphitic form, consequently the castings were soft.

On the other hand, take a 1.75 per cent. or less silicon metal—pour it into castings 1-16 to 1/8 in., and the castings are hard with 0.50 or more per cent. combined carbon. It might be reasoned that the higher silicon iron may not have set as quickly as the lower silicon iron, but it is a well-established fact that the lower silicon iron will produce hard casting of thin sections, while the same sections poured of higher silicon will produce soft castings.

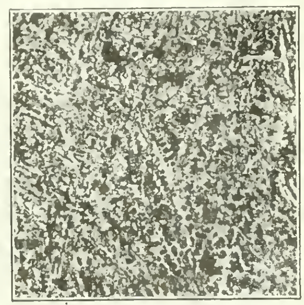
There is no graphitic carbon in steel or white iron because there is very little silicon, so no doubt Keep referred to steel or white iron—not grey rion—when he made the remark that the carbon was all in the combined form.

Semi-steel is the connecting link between iron and steel—combining the fine-wearing qualities of iron with a tensile strength of 19 to 23 tons when using 30 to 50 per cent. steel scrap in medium and heavy sections, and we justly claim it is one of the most valuable products of the grey iron foundry.

Micrograph No. 1
Thick end of wedge No. 1
Cast iron



Micrograph No. 2
Thin edge of wedge No. 1



Micrograoh No. 3
Intermediate Position,
wedge No. 1

Merits of Semi-Steel

Next to monkeys, man is the greatest imitator, so he watches other men charge steel scrap in the cupola, returns to his shop and does likewise, but not knowing the laws governing the operation he makes a mess of it. If the castings are passable, perhaps soon he is claiming to make semi-steel using half steel scrap.

Now this half-steel claim recalls the story of the man who fade a fortune through his famous pies. Soon a competitor started, but his pies were not so good although he sold large quantities.

One day a friend asked him what he was using, and he said "horse meat and rabbits." "Why," his friend says, "rabbits are very scarce, how do you manage it?" "Oh! I use a 50-50 mixture." "What?" his friend says, "half horse meat and half rabbit?" "Oh no, one rabbit mixed with one horse." And that about hits many foundrymen who claim to use large percentages of steel.

It is only those who recognise the laws of good melting, the merits and advantages of semi-steel, and place themselves in harmony with them, who share the commercial benefits of strong, clean, homogenous castings and

minimum losses—the delight of every true foundryman and engineer.

When properly made, semi-steel exceeds in both temperature and fluidity any other mixture melted in the cupola. The oxidation of the steel when melting scientifically is scarcely perceptible, and when steel is heated in the presence of coke it begins to absorb carbon from the coke, faintly at low temperature, but as the temperature is increased and the steel and coke become incandescent, the steel absorbs large percentages of carbon and no longer is the steel of commerce, but a highly carbonised metal, and will melt before the pig iron in the same charge.

The use of steel in cupola mixtures was questioned on every side—but all such theories were exploded when it was proved that carbon would be absorbed by the steel up to the saturation point, and that manganese above a certain point assisted in increasing the saturation point of iron for carbon, as steel fuses perfectly and it has a strong affinity for carbon, silicon, sulphur, phosphorus, and manganese—proving to the metallurgical world that steel improves the product and that a new principle was discovered and applied with astonishing results.

Semi-steel is made in the same cupola—in the early or the last part of the same heat with ordinary grey-iron mixtures—no extra coke, special appliances, fluxes, or new equipment are necessary.

Micrograph No. 4
Thick end of wedge No. 2—10 per cent of semi-steel. (Notice smaller graphite flakes — compared with micrograph No. 1)

Mixtures may contain 30 to 40 per cent. steel on the bed charge—then follow with 20 to 25 per cent. steel —or begin with a small percentage of steel and finish with a large percentage. Flexibility of operation is only one of the many advantages of semi-steel.

Development of Semi-Steel

There is no subject so interesting to the foundry world to-day as semi-steel, and while a great many are trying to improve their product, they cannot believe that scientific principles govern the ultimate result—even before the materials are charged into the cupola.

The object of this article is to give some plain truths about semi-steel. Many of the statements deal with historical facts dating back fifty years, while many points set forth may be disputed.

For fifty years or more foundrymen have added steel to iron in the ladle, while comparatively few melted slight amounts of steel in the cupola.

A patent was granted in England more than fifty years ago on a cupola mixture which contained only 10 per cent. wrought scrap. Major McDowell was quite successful in using steel scrap in castings of heavy section, but up to 1902 or 1903 the author could find no record of any man having used large percentage of steel in castings of light section.

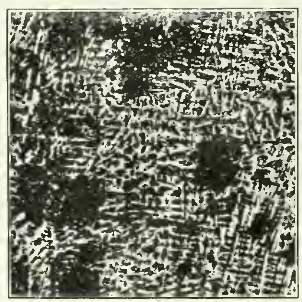
The author perfected his formula of using large percentagess of steel in light sections, and thus developed what he believes is a new metal in 1903 —and instead of giving it a fancy name, called it "semi-steel."

The author does not claim to be the first man who used steel in cupola mixtures, but no previous record has been found relating to the successful use of large percentages of steel scrap in castings of light section, and he has taught his process to foundrymen in various parts of the world since 1903.

Nomenclature

The name "semi-steel" has been abused for years, and will continue to be abused as long as men are satisfied with a mere superficial knowledge. A misapplied and misapprehended term is sufficient to give rise to fierce and interminable disputes; the term "misnomer" has often turned the tide of popular opinion; and while various authors have tried to place semi-steel on the list of misnomers, still the very fact that semi-steel was specified for shells by the Allied governments has placed it as a standard for foundrymen everywhere.

Many claim there is no much thing as semi-steel—that the steel loses its identity and is only grey iron. They forget that pig iron is used to make steel, and while the iron loses its identity they call the resultant metal "steel."



Micrograph No. 5
Thin end of wedge No. 2.

Foundrymen and engineers have also been advised "cast iron is cheap, and heterogeneous, therefore use heavier sections." This dictum has many followers, who are led to believe *one* standard mixture should be used for the entire heat, whether castings are light, medium, or heavy.

Microphotographs of Wedges showing Fallacy of Casting Different Sections from one Grade of Metal

An experiment which the author believes will prove of great interest to foundrymen is what is called "the wedge test." A pattern is made 16 in. long 2 in. square on one end, tapered to a feather edge 2 in. wide similar to a wedge. A few are moulded and cast from several different mixtures, corresponding to the metal poured in the various castings. The wedges are broken at sections which correspond to different sections of castings and the fracture noted. It will prove that it is a serious mistake to pour castings of different sections of one mixture.

If it is learnt that the metal of ½,1, or 1½ in. thickness produces a satisfactory structure for certain castings that require density to resist air, water, or other pressure, it is well to have analyses made of the casting and duplicate mixtures for future work of that character.

To prove the importance of suitable mixtures for various sections the author cast three wedge testbars 16 in. sq. at large end, tapered to a thickness of 3 16 in. Table I. gives the analyses of mixtures, and it will be noted that one is a straight grey-iron mixture and the other two, semi-steel, containing 10 and 25 per cent. steel respectively.

TABLE I.—*Analyses of Test Wedges*

Wedge No.	Material.	Si.	Si.	P.	Mn.
1	Grey iron	2.50	0.116	0.70	0.50
2	10 per cent. semi steel	2.25	0.116	0.53	0.53
3	25 per cent. semi-steel	3.00	0.085	0.40	1.05

These wedges were examined under a high-powered microscope and microphotographs made of each at the largest end, 2 in. sq., and the thinnest section, approximately 3/16 in.

Micrograph No 1 was taken from the 2-in. sq. end of cast-iron bar.

The massive black flakes are graphite; the black hairlines or nework are boundaries of white ferrite (pure iron) grains which form the main body of matrix. Here and there are islands of phosphide eutectic, which somewhat resemble a herring-bone structure.

Micrograph No. 2 was made from the same bar as No. 1 at the extreme end where the metal is as cast approximately 3 16 in. The magnification of No. 2 is the same as No. 1, but can one imagine it being of the same chemical analysis?

The light constituent is cementite with dark patches of pearlite. The metal was very hard and brittle; in fact, it was so hard that on the very thinnest edge it was partly chilled.

Micrograph No. 3 was made from the same bar as No. 2 at the section where the white chilled part appeared to be mingling with the grey.

Micrograph No. 4 was taken from the 2-in. sq. end of the semi-steel, 10 per cent. steel, wedge. While the silicon and phosphorus are somewhat lower than in the grey-iron wedge, the black graphite carbon flakes are not so large and are surrounded by white ferrite, the latter bounded by a dark grey main body or matrix of pearlite. Here and there are small segregations of what appears to be manganese sulphide.

No. 5 is a thin section of the same bar as No. 4 — the extreme light end of wedge.

The light constituent is cementite, combined carbon, Fe_3C. The dark constitnent is pearlite.

No. 6 is of the same metal as Nos. 4 and 5, but at a point where metal was chilled and the white blends into the grey.

Light constituent is cementite; dark constituent is pearlite.

No. 7 is taken from the heavy end of semi-steel, 25 per cent. steel, wedge. Compare this with No. 1 and note the difference in size of black graphite carbon flakes. The light patches at boundaries of flakes are cementite not entirely broken up. The main body of dark grey is matrix of pearlite.

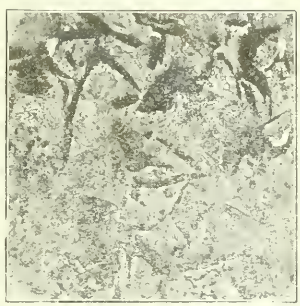
It must be understood that the author does not advise semi-steel of this analysis for castings 2 in. thick, but in carrying out the main idea of showing structure of metal at different sections, it was considered best to include semi-steel of 25 per cent. steel.

Microphotograph No. 8 was made from the same bar as No. 7 at the extreme furthest end, and metal is of the same analysis.

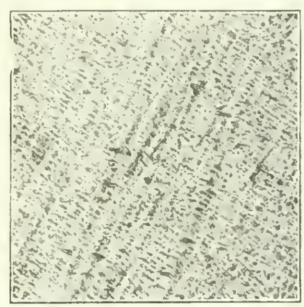
The light constituent is cementite; dark constituent is pearlite.

The semi-steel bar from which Nos. 7 and 8 were made is being used for small pistons which are about ⅜-in. thick when cast and 3/22-in when machined.

Micrograph No.6
Intermediate position



Micrograph No. 7
Thick end of wedge No. 3
25 per cent semi-steel



Micrograph No. 8
Thin edge of wedge No. 3

Medium Phosphorus

While it is well to aim for the very lowest phosphorus in certain mixtures, yet there are foundrymen who canno follow this suggestion, owing to the lack of materials low in that element, and in that event it should be remembered that, due to the small amout of phosphorus in steel—0.02 to 0.06 per cent.—the more steel used the less phosphorus in the casting.

The founder should aim to use every pound of steel scrap in his mixtures that the section to be poured will carry, especially for castings which must stand hydraulic or other tests.

Assume the mixture required is 50 per cent. pig and 50 per cent. scrap, and the estimated analysis of phosphorus is 1.00 per cent. For every 5 per cent. steel added, take out 5 per cent. pig or return scrap, and this will reduce phosphorus 0.05 per cent., leaving 0.95 per cent. This is set out in Table II.:—

Per cent. steel in mixture.	Per cent. approximate phosphorus in mixture
10	0.90
15	0.85
20	0.80
25	0.75
30	0.70
35	0.65
40	0.60
45	0.55
50	0.50

The total carbon in semi-steel is higher, and the silicon, sulphur, and phosphorus lower, that is, with the same melting condition, than if the same percentage of the best charcoal or cold-blast pig had been used instead of steel and with different melting conditions.

Steel breaks up the graphitic carbon flakes into granular form, because as the steel absorbs up to 5 per cent. carbon, a higher temperature is produced in the melting zone, and with the extremely high temperature and the metal being purer than grey iron, as it contains less silicon and phosphorus and more manganese, it is freed from impurities or gases, which insures a close-grained metal leaving no interstices for large carbon flakes.

It is not the carbons that make semi-steel better and stronger than grey iron, but the lower silicon and phosphorus that may be used, section for section, therefore many engineers and machinists prefer semi-steel.

Heretofore, if grey-iron castings of 1/4-to 3/8-in. section were to be cast, the founder would insist on high-phosphorus iron, but there are thousands of tons of semi-steel every day for light castings, with 3/16-to 3/8-in. sections, with only 0.20 to 0.40 per cent. phosphorus, and practical foundrymen are frank in saying it is the hottest metal ever seen.

Of course, the high manganese partly offsets the lower silicon and phosphorus, and with a fair percentage of combined carbon, one would expect the metal to be duller in the ladle and harder in the castings.

Steel in its descent in cupola is absorbing carbon from coke, and immediately before reaching melting zone it contains so much carbon (up to 5 per cent.) that it is not steel of commerce but a high-carbon metal that mechanically increases its temperature even above that of the melting zone, which decreases its melting point. We claim most emphatically that when good melting conditions exist steel melts first.

Scientific Melting

When steel is used in cupola mixtures the entire charging and melting conditions must be changed, especially the manner of lighting cupola and preparing it for charging.

Steel mixtures must be handled differently than iron, both before and after melting. The cupola should be hot, and care is required in charging: in fact, the author's slogan for years was: "Semi-steel must be mixed with brains," because the proper tuyere areas and blast pressures have much to do with the success or failure of it.

It has been stated, and the author believes it is a fact, that casting temperature is the secret of good semi-steel, for without the proper melting and pouring temperatures mixtures are not worth the paper they are written on.

Melting conditions in the steel foundry are approached at an entirely different angle from that of the iron foundry. In the steel foundry the melter in charge usually has many years' practical experience as a third and second hand, and must have a knowledge of furnace construction before given the opportunity to melt steel. But what a difference in the iron foundry!

The steel melter is told what percentage of elements is desired in his steel, and he calculates his charge accordingly. Later, as the heat progresses, he is guided by the actions and reactions taking place in furnace, and then decides what percentage of the deoxidisers (silicon, manganese, or other alloys) is necessary to produce steel within the specifications, but he never attempts to melt steel in a cold furnace.

What a difference the author found when he first began using steel in the iron foundry! Like the majority of foundrymen of those days, he thought he knew all about a cupola, although his foreman claimed to know a great deal more, but between them scant attention was given to the cupola operation. Why?

The cupola was there. It melted iron every heat and had done so for many years. Therefore the author believed the men in charge must understand the process, or, if they did not, the foreman would tell them. But did they? They knew how to melt iron, but the science of melting and the knowledge of cupola details was, and is, sadly lacking in many shops, even to-day.

High blast oxidises a large amount of manganese, silicon, and carbon. By lowering the total amount of carbon a higher percentage of combined carbon is obtained which increases the percentage of oxygen, nitrogen and oxides—all of which have caused many to condemn semi-steel.

To make real semi-steel, one must be familiar with the fundamentals of scientific melting and the use of steel scrap in cupola mixtures.

High carbon is more essential than high silicon in thin sections for all metal tested to air or water pressure, hence the silicon may carried much lower than is possible in like sections of grey-iron castings.

But how easy it is to make this assertion look absurd and untrue! The majority of foundrymen have never paid much attention to melting steel scrap in the cupola, and when doing so generally follow someone else's advice, who probably does not know any more about it than they.

They charge the steel in the cupola without a thought concerning its melting, that is, they do not pay attention to whether high or low blast is used. If high blast is used the resultant metal is condemned. It has been proved that while steel could be melted in any cupola, still the metal was not to be depended on, unless good melting conditions existed.

Annealed Semi-Steel

Some years ago a concern using both steel and malleable castings desired to produce a more satisfactory metal for their product. This company manufactured a line of tools for the hardware and automobile trade. An investigation proved that neither the best malleable nor steel castings gave them the desired results, and our study of the treatment given both malleable iron and steel castings led the author to believe a more suitable metal could be made of annealed semi steel.

Annealed semi-steel is preferable to either cupola or standard malleable iron for certain castings, as different percentages of steel may be used, depending on section and strength required. It may be hardened and tempered, and the tensile strength is considerably greater than the best malleable iron.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

It is the author's belief that annealed semi-steel will supersede cupola malleable for castings more than ¼-in. thick, and even now several railroads are investigating its adaptability for castings over ½-in. section, as the tensile strength will run from 25 to 30 tons.

The cost of producing annealed semi-steel in comparison with malleable iron will depend on the tonnage melted per day, but we believe that, ton for ton, annealed semi-steel would cost less than the best malleable iron.

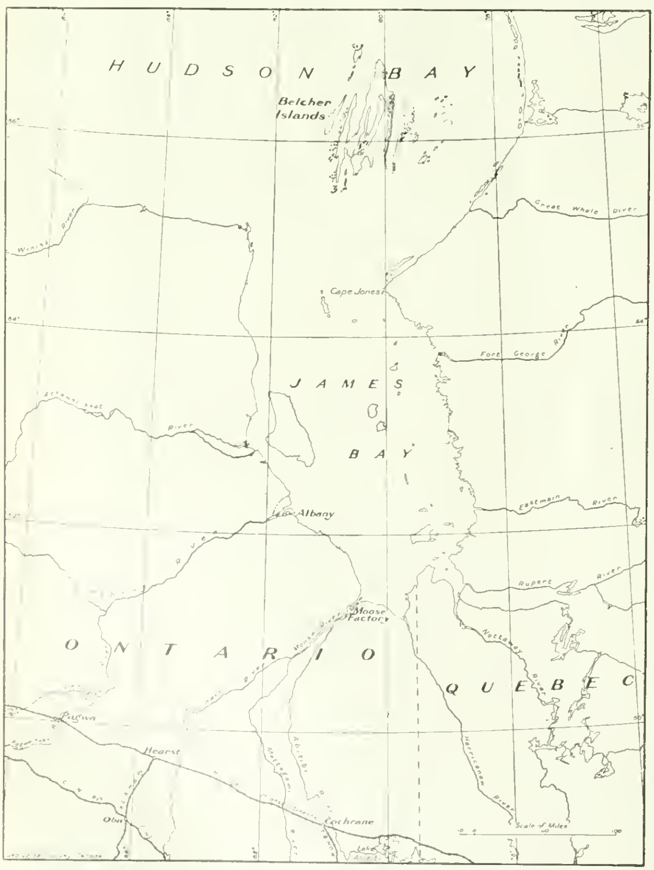
Annealed semi-steel is white when cast. It is annealed from three to seven days, depending on the sections, and recent experiments of heat treatments lead to the belief that quite a reduction of time will be experienced during the annealing period.

Foundrymen who lack sufficient confidence to make semi-steel instead of straight grey-iron mixtures will hardly be expected to believe that some of the castings made are cast of annealed semi-steel. This metal is made in the cupola, and is very good for wearing purposes, but, of course, will not stand shocks like alloy steels. Annealed semi-steel is very homogeneous, will twist or bend, may be hardened, will stand very high polish, and wears extremely well.

The Iron Ore on Belcher Islands

There has just been published by the Geological Survey, Ottawa, as Summary Report, 1921, Part E, *Iron-bearing Rocks of Belcher Islands, Hudson Bay, by G. A. Young*. This report of 61 pages, with three sketch maps, gives in its first three sections a comprehensive account of the geological occurrence of the extensive beds of iron formation, and in its final chapter a non-technical discussion of the economic features of the case.

The iron formation is of the banded siliceous type common in Ontario, 300 to 450 feet in thickness. It is underlain immediately by quartzite, and beneath that by slate and limestone. Above it in the sedimentary series is ellipsoidal basalt, from which it is separated, however, by a thick sill of diabase intruded uniformly at the juncture of iron formation and basalt. The rocks have been folded into a succession of anticlines dipping at various angles up to the vertical, along the eroded tops of which the iron formation now is exposed. These north and south folds give to the Belcher Islands their elongated shape. It is suggested that the sedimentary rocks are Animikean in age.



By Courtesy of the Geological Survey.

BELCHER ISLANDS HUDSON BAY

Iron Formation underlies 150 square miles of land surface on the eastern side.

INDEX TO MILL SUPPLIES

(Continued).

Cranes, Electric Travelling:
Northern Crane Works, Ltd., Walkerville, Ont

Cranes, Locomotive:
Northern Crane Works, Walkerville, Ont.

Cranes, Travelling, Electric, and Hand Power:
Northern Crane Works, Walkerville, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal
Volta Mfg. Co., Welland, Ont.

Crucibles:
Hyde & Sons, Montreal, Que.

Cupolas:
Northern Crane Works, Walkerville, Ont

Cupolas, Foundry:
Northern Crane Works, Ltd., Walkerville, Ont.

Damp-proof Coating:
Beveridge Supply Company, Limited, Montreal.

Derricks:
R. T. Gilman & Co., Montreal.

Dies and Die Stocks:
Canadian Fairbanks-Morse Co., Montreal, P.Q.

Drop Forging:
Steel Company of Canada, Ltd., Hamilton, Ont.

Dump Cars:
McKinnon Shell Co., Sherbrooke.
R. T. Gilman & Co., Montreal.

Dust Arresters (for Tumbling Mills):
Northern Crane Works, Walkerville, Ont

Dynamos & Electrical Supplies:
Can. General Electric Co. of Canada, Ltd., Toronto.
Electrical Fittings & Foundry, Ltd., Toronto
Volta Mfg. Co., Welland, Ont.

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Wentworth Mfg. Co., Limited, Hamilton, Ont.

Emery and Emery Wheels:
Wilkinson & Kompass, Hamilton, Ont

Engines—Heavy Oil:
The Dominion Steel Products Co., Ltd., Brantford, Can.

Enameling Finish Steel Sheets:
Seneca Iron & Steel Co., Buffalo, N.Y.

Fans:
Smart-Turner Machine Co., Ltd., Hamilton, Ont.

Fence Staples:
British Empire Steel Corporation, Ltd.
Canadian Tube & Iron Co., Ltd., Montreal
Dominion Iron & Steel Coy., Ltd., Sydney, N S
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Ferro-Manganese:
A. C. Leslie & Co., Ltd., Montreal.

Ferro-Silicon:
A. C. Leslie & Co., Ltd., Montreal.

Fibre, Vulcanized:
Beveridge Supply Company, Limited, Montreal.

Fire Brick:
Elk Fire Brick of Canada, Ltd., Hamilton, O.
Crescent Refractories Co., Curwensville, Pa. U.S.A.
Ironton Fire Brick Co., The, Ironton, Ohio.

Fire Brick Cement:
Leslie & Co., Ltd., A. C., Montreal, P. Que.
National Fireproofing Co. of Canada, Ltd., Toronto
Hyde & Sons, Montreal
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.

Fire Brick, Jointless:
Beveridge Supply Company, Limited, Montreal.

Flooring Materials:
Beveridge Supply Company, Limited, Montreal.

Fluorspar:
Canadian Industrial Minerals, Ltd., Toronto, Ont.

Forgings:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Forgings, Marine:
Canada Foundries & Forgings Ltd., Welland, Ont.
Steel Co. of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Forgings, Automobile:
Canada Foundries & Forgings Ltd., Welland, Ont.

Forgings, Iron and Steel:
British Empire Steel Corporation, Ltd.
Dominion Steel Foundry Co., Ltd., Hamilton, Ont.
Nova Scotia Steel & Coal Co., Ltd., New Glasgow, N.S
Dominion Steel Foundry Co., Hamilton, Ont.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Forgings, Drop & Locomotive:
Canada Foundries & Forgings Ltd., Welland, Ont.
Steel Co. of Canada, Ltd., Hamilton, Ont.

Foundry Supplies:
Hyde & Sons, Montreal, Que

Furnaces, Annealing:
Canadian Incinerator Co., Ltd., Toronto, Ont
Pittsburgh Electric Furnace Corp.

Furnaces, Blast:
Toronto Iron Works, Toronto, Ont.
Pittsburgh Electric Furnace Corp.

Furnaces, Forging.
Canadian Incinerator Co., Ltd., Toronto, Ont.
Pittsburgh Electric Furnace Corp.

Furnace, Electric Equipment:
Pittsburgh Electric Furnace Corp.

Furnace Linings:
Quigley Furnace Specialties Co., New York.
Dominion Foundry Supply Co., Ltd., Montreal.

Furnaces, Electric:
W. E. Moore & Co., Ltd., Pittsburg, Pa.
Pittsburgh Electric Furnace Corp.
Volta Mfg. Co., Welland, Ont.

Ganister:
American Refractories Co.

Glass and Pin Wire:
The Seneca Wire & Mfg. Co., Fostoria, Ohio, U.S.A.
United States Steel Products Co., Montreal.

Gear Boxes, Reduction:
Hamilton Gear & Machine Co., Toronto, Ont.
Hull Iron & Steel Foundries, Ltd., Hull, P.Q.
The Dominion Steel Products Co., Ltd., Brantford, Can.
Smart-Turner Machine Co., Ltd., Hamilton.

Gear Drives—Herringbone:
The Dominion Steel Products Co., Ltd., Brantford, Can.

Gear Cutting Machinery:
Hamilton Gear & Machine Co., Toronto, Ont.
The Dominion Steel Products Co., Ltd., Brantford, Can.
Smart-Turner Machine Co., Ltd., Toronto, Ont.

Hardware:
Beals, McCarthy & Rogers, Buffalo, N.Y.

Hoists:
R. T. Gilman & Co., Montreal.

Hoists, Air:
Canadian Mead-Morrison Co., Welland, Ont.
Northern Crane Works, Ltd., Walkerville, Ont.

Hoists, Electric:
Canadian Mead-Morrison Co., Welland, Ont.
Northern Crane Works, Ltd., Walkerville, Ont

Hoisting & Conveying Machinery:
Northern Crane Works, Walkerville, Ont.
Sterling Engine Works, Winnipeg, Man.

Hoops:
United States Steel Products Co., Ltd., New York.
Leslie & Co., Ltd., A. C., Montreal, P. Que.

Hose, Fire & General, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont

Ingots:
British Empire Steel Corporation, Ltd.
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.

Iron Bars:
Steel Company of Canada, Ltd., Hamilton, Ont.

Locomotives:
R. T. Gilman & Co., Montreal.

Mattress and Broom Wire:
The Seneca Wire & Mfg. Co., Fostoria, Ohio, U.S.A.
United States Steel Products Co., Montreal.

Mechanical Products, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont

Machinery, Wire Mill
The Dominion Steel Products Co., Ltd., Brantford, Can.

Market and Bundling Wire:
The Seneca Wire & Mfg. Co., Fostoria, Ohio, U.S.A.

Metal: Expanded:
Bains & David, Limited, Toronto, Ont.

Metals, High Speed Cutting:
Deloro Smelting & Refining Co., Ltd., Toronto, Ont

Metals—Ignots:
Leslie & Co., Ltd., A. C., Montreal, P. Que.

Metal Spinning:
Wentworth Mfg. Co., Limited, Hamilton, Ont.

Magnesite:
The Scottish-Canadian Magnesite Co., Ltd., Montreal
American Refractories Co.

Motors:
R. T. Gilman & Co., Montreal.

Motors, Electric:
Lincoln Electric Co. of Canada, Ltd., Toronto.
Moloney Electric Co. of Canada, Ltd., Toronto, Ont.

Motor Fuel:
British Empire Steel Corporation, Ltd.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S

Nails, Wire & Cut:
British Empire Steel Corporation, Ltd.
Steel Company of Canada, Ltd., Hamilton, Ont.
United States Steel Products Co., Montreal.

Nuts (up to 4 in.):
Steel Company of Canada, Ltd., Hamilton, Ont.

Oxy-Acetylene Welding:
Oxyweld Co., Limited, Toronto, Ont.

Packing, Piston, Rod & Sheet Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont

Patent Solicitors:
Stanley Lightfoot, Toronto, Ont

Patterns:
Dominion Pattern Co., Toronto, Ont.

Pig Iron:
Algoma Steel Corporation, Sault Ste. Marie, Ont
Dominion Iron & Steel Co., Ltd., Sydney N.S
M. A. Hanna & Co., Cleveland, Ohio.
Steel Co. of Canada, Ltd., Hamilton, Ont

Extent of Iron Formation

The exposures of iron formation and of iron ore are along the eastern edge of Flaherty Island, the principal island of the group, and a long peninsula that skirts its eastern side, and on two long islands that parallel this side at a distance of from six to twelve miles. The parallel outcrops of iron formation are parts of one bed, folded and then eroded so as to present these various exposures.

Dr. Young examined about 40 miles of the outcrop of iron formation and observed it at a distance, from a boat, for an additional length of 70 miles. From the outcrop thus determined and from data as the dip of the strata he estimates that at least 150 square miles of land surface is underlain, at no great depth, by iron formation. Of the 40 miles of outcrop examined, only 10 miles was sufficiently well exposed to allow of the unreserved statement that beds of iron were present or absent. With an unimportant exception, the general character of the iron formation was the same throughout.

The Ore

"In each area examined on the several outcropping bands of iron formation, highly ferruginous bands were found, and where the formation was fully exposed two or more such zones were always in evidence. In thickness the individual zones vary from 10 feet to 50 feet." Three representative samples across the zones gave iron from 35 to 45%, and silica from 46 to 32%. One sample gave iron 52% and silica 24%. The ferruginous zones contain lean, siliceous bands capable of removal by hand picking, when the remainder of the zones would reach 50% in iron or over, and the silica would be reduced to 20%; but this would be expensive.

It is probable that these ferruginous zones owe their comparatively high content of iron to the character of the original deposition and not to a process of concentration such as caused the forming of commercial ore-deposits on the Mesabi range. However, as the character of the iron formation is not (in distinction to some found in Ontario) such as to prelude the possibility of concentration by this means, it is possible that ore-deposits of commercial grade occur, through now effectually concealed by a mantle of drift.

In conclusion Dr. Young points out that since the sedimentary beds are consistent in character and regular in their disposition, any work of exploration "should "consist of methodical geological examination of complete "natural or artificially-bared cross-sections of the iron "formation made at intervals along the course of each "outcropping band". Such prospecting he recommends in preference to the more costly diamond-drilling which, in this case as usual, should be resorted to only when the outcrops have been examined thoroughly.

PRODUCTION OF IRON AND STEEL

September, 1922

The monthly report of the Dominion Bureau of Statistics states that the production of pig iron in September declined 7.92 per cent. from the output of the previous month, the respective tonnages being 27,123 long tons in August as compared with 24,974 tons in the month under review. The production was also less than that of September last year by 40.8 per cent. A comparison of the cumulative production during the first nine months of 1922 with that of the corresponding period last year shows a decrease from 457,157 tons to 275,989 tons or 39.6 per cent.

One furnace was blown in at Hamilton and another at Sydney while one of the furnaces at Sault Ste. Marie was banked. At the end of the month, then, the active furnaces numbered two at Sydney, one at Hamilton and one at Sault Ste. Marie, a net gain of one furnace over the previous month.

Another development was the slight increase in the several grades of iron produced for sale. The production of basic pig iron increased from 6,577 tons in August to 7,991 tons or 21.5 per cent. The September production intended for this purpose was also higher than in September of last year by 58.14 per cent. The foundry pig iron produced for sale increased from 6,296 tons in August to 6,895 tons in September. The output of malleable iron for sale also rose from 281 tons in August to 1,096 tons in the month under review.

The production of ferro-alloys dropped slightly from 1,864 tons in August to 1,834 tons in the following month. The cumulative production during the first nine months of 1922 was 15,178 tons as compared with 18,698 tons during the corresponding period of the previous year.

The production of steel in September declined by 23,373 long tons from the output of 59,160 tons in August to 35,787 tons in the month under review. The cumulative output during the first nine months of 1921 was 477,588 tons as compared with a production fo 334,835 tons in the corresponding period of the present year. The closing of the steel plant at Sault Ste. Marie accounted in large measure for the decrease in production during September.

The output of basic open hearth ingots for further use declined from 56,997 tons in August to 33,815 tons in September, a decrease of 23,182 tons or 40.7 per cent. A small quantity of electric steel ingots for further use amounting to 124 tons was reported for September while none was made for direct sale.

The total production of ingots was less than the output of the corresponding month of last year by 20,540 tons or 37.7 per cent. The production in the first nine months of 1922 was 319,943 tons while that of the corresponding period of the previous year was 459,960 tons representing a decrease of 30.4 per cent. The production of steel castings also suffered a decline. The total output in August was 2,204 tons which decreased to 1,848 tons in the month under review. The decline amounted to 356 tons or 16.15 per cent. An opposing tendency developed in connection with basic open hearth castings of which the production increased from 208 tons to 837 tons. On the other hand the output of Bessemer and electric grades declined considerably.

Peter A. Frasse and Co., Inc., 417 Canal Street, New York, announce the introduction on this continent of a chemical preparation, at present in extensive use in Europe, for removing rust from metals. It is stated that a solution of one part of this preparation in 25 parts of water will effectively remove rust from iron, steel and other metals without attacking at all the metal itself. No scraping or rubbing is required, the action being entirely chemical. It is said that the addition of a small percentage of the preparation to a pickling bath of either sulphuric or hydrocholoric acid will prevent the formation of hydrogen, which is now generally believed to be the cause of pickling brittleness in steel. The addition of this substance to the pickling bath will likewise save 50 per cent. of the sulphuric acoid used by preventing the solution of un-oxidised metal, over-pickling being thus avoided.

EDITORIAL

There are some subjects with which governments can give assistance, and their assistance is always welcomed; but the mineral industry is one that does not flourish under paternalism, and advice such as has sometimes been offered in this country is not welcomed.

"How small a part of all that we endure
Is that which governments can cause or cure."

W. G. Miller —1910.

WHY PUBLIC SUBVENTION?

We quote today, above, the words of a leader in the mineral industry of Canada whom time has proved to have both sound judgment and prophetic vision. The quotation is apt today on account of a present case in British Columbia to which it appears to apply with a force equal to that in its original context. The prospective iron ore industry of British Columbia is in danger of being subjected to highly artificial and paternal treatment, such as has been shown often to be in oppositiou to the genius of British commercial life, and seldom leads to a good and lasting result, of maximum benefit to the community that has footed the bills.

British Columbia has iron ore, and plenty of it. For a generation or more, the owners of a number of first-class deposits of magnetite on the coast and coastal islands have paid taxes on their property in the hope that there would be developed a market for it. A number of these owners have expended large sums of money in developing their ore-bodies, and are not only willing but anxious to realize on their investment, either by selling ore at a reasonable rate or by selling their holdings. Metallurgical coal is available at tidewater in comparative abundance. Hydro-electric power (if that should be required) is available on the mainland at fairly reasonable rates, though only in quantities that might not be adequate for large electro-metallurgical operations. British Columbians do not lack the initiative that leads to the utilizing of natural resources such as these. What is lacking to stimulate their use?

Apparently it is the lack of an adequate market that has deterred all the numerous commercial interests that have investigated the field, from investing their money in a Pacific iron and steel plant. The capacity of this market has been ably summarised by Dr. Stansfield in his report to the British Columbia government in 1919. It is nicely adequate to absorb the products of an electric smelting plant; but that is quite a different dimension from the requirement for a regular blast-furnace plant. It has been proposed to include in the market available for a smelter in British Columbia, the western United States; but that is obviously unsound, as it is the avowed and consistent policy of the United States to exclude manufactures from foreign countries as soon as their importation intenferes noticeably with domestic manufacture. Similarly there is no substantial prospect of a trans-Pacific export market, as the iron and steel production of India, founded upon unsurpassed resources of iron ore and cheap metallurgical coal and labour, has commenced already to demonstrate its ascendancy in that quarter of the globe.

There is no doubt that, if there were a genuine opportunity for lucrative investment in a modern blast-furnace and steel plant in British Columbia, one or other of the iron and steel firms that have examined the field during recent years would have seized it. There is likewise no doubt that British Columbians can institute such an industry—if they are willing to pay the price. The danger is that specious argument, directed by selfish interest, may blind them to the truth and may commit them to a course that will add to their financial burden without the certainty of effecting the end they all desire. If the half-million population of the Pacific province were augmented to say, two million (as it will be, no doubt, before the present youth of the province have reached old age), then the risk of public funds in the establishment of an iron and steel industry might well be justified.

Meantime, it seems more reasonable to look for the establishment of the much-desired plant by another means, more in accord with present conditions. A short time ago it appeared as if the small-scale production of an electric smelting plant might be feasible, and only the non-availability of cheap electric power prevented its recommendation by Dr. Stansfield. It might well be that a commercially successful electrolytic process will be evolved, whose comparatively small unit production would suit the needs of British Columbia's sparse population. We believe that, until the province's own need is sufficient to absorb the production of an iron and steel plant of the regular type, effort will be best expended in the search for a method of producing iron from its ores that is fundamentally in accord with all the important factors of the case.

RESEARCH ASSOCIATIONS

Constantly there is noticed these days in the technical press of Britain and the United States the accomplishment of the numerous Research Associations in both countries. There is, as well, an effective international *liaison*, which is remarked and acknowledged frequently on both sides of the Atlantic. The progress of these associations during the last few years both in numbers and in size has been decidedly marked, and rests not only upon the faith of those responsible for the organizations and the stimulus due to a sense of public service, but also (and mainly) upon tangible results, measurable in dollars and cents, or in pounds, shillings and pence. Many of the research associations, young as they are, and painful and slow the progress of most research, have already more than justified their existence.

In Canada we have as yet made hardly a beginning in the establishment of Research Associations. We have been thus negligent in the face of the fact, now generally recognized, that co-operation in research is one of the surest means toward the end of industrial progress. This is no longer a matter of opinion; it is a matter of fact. It was proved long ago in Germany, but only lately has the idea been applied generally throughout the Anglo-Saxon world — excluding Canada. It is not that we Canadians do not need the aid of industrial research; we are in need of it as much or more than any other country. It is not that our industries are insufficiently developed to support the expense of combined research; we have a number of well-founded industries of outstanding importance. It is not that we have lacked information as to the value of co-operation research and the means to its adoption; the subject has been discussed almost *ad nauseam*. Our inability to act when action is so clearly demanded is inexplicable, unless the reason is that we Canadians are still too near the pioneer stage of development to allow of efforts that are more characteristic of a more advanced stage of civilization.

Nowhere does widespread co-operative research offer a more promising field than in our iron and steel industry — an industry that has been transplanted from foreign soil. Our iron and steel industry is, as yet, in the main, not firmly rooted, since it still draws its sustenance from a foreign soil, aided by an artificial fertilizer in the form of a tariff. It would wither away at once were the sources of raw material in a foreign land cut off. It is doubtful if any of the basic producers except that in Nova Scotia would survice the abolition of the tariff.

Surely this is a case for serious and concerted effort by our iron and steel men. A Research Association offers the surest and most economical means towards the end of building up an indigenous, or even partly indigenous, iron and steel industry. The Advisory Research Council in Ottawa is authorized to aid and abet the organization of such associations, and has both full information and financial means at its disposal toward this end. Who among the iron-masters of Canada will make the first move?

IRON AND STEEL IN SOUTH AFRICA

An interesting move has been made lately in the interests of a well-founded iron and steel industry in South Africa. It embodies so much that is sound and far-sighted in its planning, and involves aid from the public purse in such a rational way, that a review of its provisions may well repay us Canadians, who have made rather a hash of our own attempts along similar lines.

South Africa is well provided with metallurgical coal of fair quality, in conjunction with good deposits of iron ore, centrally located within her territory in the Transvaal and the Orange River Colony. The home market is large enough to absorb the product of a blast furnace and of steel mills of moderate size. The prospective market lends colour to the belief that the initial iron and steel works, of minimum proportions, will assume very important dimensions in the long run. It has, indeed, been hinted by some students of the subject that South Africa may eventually assume a leading part in the world's iron and steel industry.

General Smuts has been the spokesman in announcing the basal conditions for government aid to the new industry. First of all, it has been expedient to combine under one management the two plants already erected with private capital. It has been arranged to merge the Union Steel Corporation of Vereeniging and the South Africa Iron and Steel Corporation of Pretoria. There is no room for competition at the commencement. This merger has been arranged in London, and it is reported that a leading firm of British steelmakers have become identified with the merger. Ample capital has been assured by this means.

In order to attract capital to this new field, the government of South Africa has considered it expedient to offer a bonus for the production of iron and steel. This is in the form of a bounty, which it is expected will be at the rate of 17s. 6d. per ton for the first three years, 15s. per ton for the next three years, and then an annual reduction of 2s. 6d. per ton until the bounty stops. This scale is somewhat in excess of the rate authorised by act of parliament last year. It is calculated that these bounties will suffice to pay the interest on the capital investment required while the plant is building and until it becomes established in a steady production. It seems to be well assured that after being once established, the industry will be sufficiently profitable to pay for its own further development.

It has been pointed out very clearly that this bounty is merely an expedient to attract capital and thus give the iron and steel industry a start. What General Smuts and his technical advisers consider as the prime essentials for continued successful operation are cheap railway rates and the establishment of diverse subsidiary industries. In other words, they consider that the establishment of a well-founded basic iron and steel industry will induce a general industrial development. There is plenty of warrant for this conclusion.

We Canadians have not been blessed by Nature with the fortunately situated resources in iron and coal that South Africa enjoys. Our task has, therefore, been harder. But a large part of our effort and of the public funds expended have been wasted. We lacked the leadership of a man with the vision and force of General Smuts, to bring together the forces of progress and send them forward, united, on the road to lasting accomplishment. Too many mis-directed enthusiasts and commercial adventurers have been allowed to tamper with Canada's iron and steel industry. Still, there are grounds for hope that we shall yet have an iron and steel industry that will do much to ensure our industrial independence and that will be a credit to Canadian brains and initiative.

EDITORIAL NOTES

Today we print, once again, an appeal for a more effective organization of scientific research throughout our Dominion. This might seem to be unnecessary, in view of the belief, now wide-spread, of the efficacy of research in stimulating and aiding profitable industrial enterprises, as well as in helping the prime producer, be he farmer, miner, lumberman or fisherman. The sad fact is that, though there is a vague idea of the value of research it is applied as yet in concrete instances to such a small extent that Canada tends to lag behind the rest of the world by reason of not seizing her opportunities promptly and with intelligence. Research is the intelligence service of the advancing army of industry, as well as its engineer corps to clear the roads and build bridges. We make no apology for harping constantly on our need for more, and better, facilities for research.

The trade returns for Canada for the twelve months ending October, 1922, include the following items:

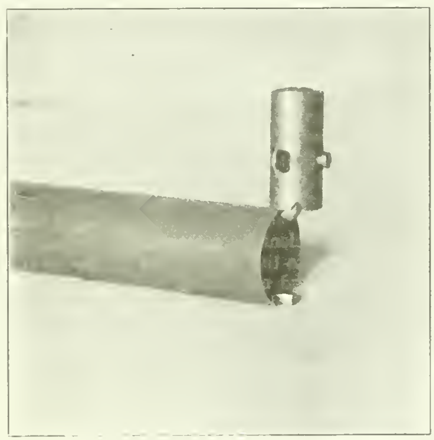
Imports	
Iron and its Products	\$120,901,813
Non-Ferrous Metal Products	33,649,163
Non-Metallic Mineral Products	116,654,048
Exports	
Iron and its Products	\$38,087,096
Non-Ferrous Metal Products	34,747,516
Non-Metallic Mineral Products	23,058,672

These figures may well provide food for thought for all Canadians, and particularly for the iron and steel metallurgists of Canada, upon whose initiative and resource our country must depend mainly to stop this annual drain upon income.

A STAMP FOR THIN TUBING

A somewhat novel stamping tool designed specially for the purpose of placing small identifying marks on the ends of thin tubing, is shown in the accompanying engraving. This is being used in connection with a material tracking system to facilitate the locating of any particular part. Four different marks can be made with this tool; but the special feature is the manner in which it supports the work while stamping. Some kind of internal support is, of course, absolutely essential to avoid distortion; but the general practice of using a separate piece to insert in the tube leaves room for improvement on account of the length of time required, and the objection there always is to loose parts.

The dimensions of this tool depend upon the size of tubing it is intended to be used on. The reader will obtain an approximate idea of what these should be from a glance at the photo.



The support piece is made from round stock—machine steel will do nicely—bent in the form of a square as shown, to fit snugly the bore of the tubes. The stamp itself is also made of round stock—cast steel—drilled down the center to slide on the straight portion of the supporting piece and filed with crossed Vee slots on the bottom to separate distinctly the four stamping marks that are afterwards cut in. Two through holes drilled at right angles in the center of the stamp clear the screw in head, which is inserted in a tapped hole in the support piece. These holes must be bigger than the head of screw so that the latter, while acting as a locating point for the four stamps by passing it through the different holes and thus forming a simple means for keeping both parts together is yet loose enough to allow the stamp to move up and down slightly. Tubes stamped on the ends by this tool show no distortion whatever.

The use of molybdenum appears to be getting on a sounder footing than ever before, and the manufacturers who use it believe that as a toughener of steel it serves a real purpose when added to carbon steels in quantities reaching 0.35 per cent. It is used in automobile axles and springs and in shovels.

Research in Canada

MORE SYSTEMATIC AND MORE INTENSIVE RESEARCH WORK NEEDED

by GARNETT W. RICHARDSON

"Original Research is in itself the most powerful weapon that ever has been or ever can be wielded by mankind, in struggling with the great problems which Nature offers on all sides for solution".

Prof. Meldola

During the latter part of the late war, and since that time, the part that scientific research and discovery have played in the intense international industrial competition has had a marked effect in helping to bring prosperity again to the world. European countries have probably been foremost in this research seconded possibly by the United States. Sad to relate Canada has been somewhat backward in her research activities.

Research Officially Recognized in Canada

In 1916, by Order-in-Council, the Government of Canada established an Honorary Advisory Council for Scientific and Industrial Research. The Council was authorized to make an investigation into the various agencies conducting research in the universities, and especially, to quote from the Order-inCouncil, "to become acquainted with the problems of a technical and scientific nature that are met with by our productive and industrial intersts, and to bring them into contact with the proper research agencies for solving these problems, and thus link up the resources of science with the labour and capital employed in production, so as to bring about the best possible economic results".

When the Council commenced their investigations, they found "that scientific research in Canada was practically confined to the laboratories of two or three of our universities, and one or two departments of the Government." They also found the absence of any scientific control in the industries. Consequently the waste in our industries was tremendous, and we can easily understand the difficult task that confronted the Council. However they succeeded in directing attention to the value of scientific research by lectures, bulletins, and addresses.

A series of studentships and fellowships was established to encourage university graduates to enter the field of research, and substantial assistance was given to research, both academic and industrial. The relationship between science and industry was fully recognized by the Council, and they set about to bring "an intimate co-operation between those who could set the industrial problems, and those whose knowledge and training would aid in their solution."

In 1917 it was proposed that a Central Research Institute be established at Ottawa, to develop both scientific and industrial research in Canada. A Bill to this effect was brought before the House of Commons, and was carried almost unanimously. However, the Bill was turned down by the Senate on the grounds of economy, and has not as yet been re-introduced. As a matter of fact, though, a small grant has been given each year since that time by the Government to enable the Council to carry on a limited amount of work. It may be stated without prejudice to the Government, that every moment lost in inaugurating an adequate Research Institute means a tremendous loss in our industries, and the falling behind of our country in the ever-increasing international industrial competition. The Administrative chairman of Advisory Research Council in his report for the year ending March 31, 1920, states that "the urgency of the establishment of this Institute is of the first order of importance, and every year lost in effecting this establishment will increase the difficulties which Canadian industry will face in competition with industry abroad, aided by all the resources that scientific research will place at its command."

To Hamper Research is False Economy

Economy is no argument against the establishment of a Canadian Research Institute. Anyone using this argument shows lack of information on the real value of research. A few results of scientific research in some other countries may be given here appropriately. In the United States at the Mellon Institute in Pittsburg, a few years ago a research into improved methods of ciation of bakers. With the expenditure of some $5,000, certain discoveries were made almost immediately that enabled the bakers to affect a saving of $500,000 annually. Needles to say, the bakers paid the investigator a very generous bonus. A few other cases relating to the financial returns from research in the United States may be cited. In one case an industry, founded with a capital of $25,000, had accumulated $200,000 of assets at the end of two years, and was doing a busines of $1,000,000 annually. In another case an industry started in a small way was making a monthly profit of $50,000 at the end of eighteen months, during the first six months of which the business was in the experimental stage. It has been stated authoritatively that over fifty industrial concerns in the United states have established research laboratories on an extensive scale and many of these expend from $100,000 to $300,000 on research work alone. The most prominent Government research agency in the United States is the Bureau of Standards, at Washington, D. C. This establishment bread making was undertaken, at the instance of an asso- employs about three hundred scientific workers, and handles the greatest diversity of problems. It tests and conducts original researches on papers, textiles, structural and other steels, building and roofing materials, cements, paints, inks, chronometers, thermometers, barometers, electrical apparatus of all sorts, radio-active preparations, and in fact anything and everything to which a mechanical, physical, or chemical test can be applied.

Official Aid to Research in Britain and Elsewhere

In England, during the course of the war, a State Department of Scientific and Industrial Research was organized, and a fund of a million pounds was placed at the disposal of the Department of research work. One of the foremost activities of this Department has been in getting together manufacturers in the same industry for the founding of research laboratories on a co-operative basis. In connection with the mining industry, studies have been made of the carbonization of coal, light alloys, refractories, concrete, the corrosion of non-ferrous metals, insulating oils, and many other such problems. Great economies have been effected in the recovery of tin from the mines in Cornwall. Porcelains imported in considerable quantity from Germany before the war have been replaced by very satisfactory substi-

tutes made from British clays. Also, for the furtherance of research in the mining industry the British Non Ferrous Metals Research Association has been formed and is doing very valuable work.

An instance in England of the value of authoritative scientific councel in its relation to industry may be instanced. One of the largest steel corporations in England had, until 1914, been importing from Austria through a German agency, a certain material for lining its converters. When war was declared they had a two years' supply on hand. As time wore on and the supply diminished, the directors were obliged to call for scientific advice. They were referred to the geologists, who informed them that a bountiful supply of the material in question was available in the immediate vicinity of their plant. This information was acted on, with the result that the company is now mining in sufficient quantity on its own account the material formerly imported from Austria at many times the present cost.

France has kept pace with other countries, and has an Academy of Science to her credit. In Japan an Institute for Physical and Chemical Research has been established, at a cost of over two million dollars, this expenditure being shared equally by the Government and the manufacturers. These are only a few instances of the research work being done in other countries; innumerable other instances might be given. It is apparent that if Canada is even to keep her present status in the present international industrial competition, greater attention must be given to the fostering of scientific institutions. It should be the duty of the Government to grant a liberal sum for the establishment of research laboratories, and for their maintenance for a limited period of time, until the industries concerned could take them over. Then the prosecution of industrial research on a co-operative basis could be delegated to the interests themselves, an association of manufacturers in each branch operating the laboratories for the common benefit.

What is Research?

Occasionally we find persons having only a vague idea of which "research" really means. The right Hon. Lord Moulton, K. C. B., F. R. S., in his introduction to the volume published by the Cambridge Press entitled "Science and the Nation", says, "the word 'research' has of late years been used too frequently as little more than a cant phrase, dear to educationalists, but carrying with it no clear or definite meaning, and if there is any patent or latent hostility to research it is mainly due to the way in which the word has thus been treated by its self-styled champions. But (as I am glad to say is frequently the case even in the arena of legal conflicts) the blunders of the advocate have not been sufficient to hide the merits of the case. Not only thoughtful educated men but even numbers of the general public are beginning to realise that it is to research in its proper signification that we owe the knowledge of the wealth of the world in which we are placed —of the power that is within our grasp. The man engaged in research is like the mining prospector who may discover that rocks, which seem to the ordinary eye indistinguishable from the barren masses that surround them, are in reality teeming with riches. But for research one would never have known that the coal-tar oil which resemble so closely in their general characteristics the Paraffins or Petroleums are capable of entering into combinations of such novelty and complexity that they now furnish the whole world with dyes and chemical products of priceless value. It is the application of research to the problems of metallurgy that has caused the additions to our knowledge of metals during the last 50 years to be greater than all that has been learnt in the ages that had elapsed since man first began to work metals. And what is most remarkable of all, we find that through the introduction of research the empirical handling of the problems of organic life is being step by step replaced by an assured treatment based on a conscious and realised connection between cause and effect. All these changes are due to Research. Scientific research has removed our previous ignorance of the properties and powers of the things around us and has taught us what they are and how they can be used. It is not too strong a simile to say that without the teaching of Science man blunders through life much as a card player would blunder through a game of cards if he did not take the trouble to look at the cards in his hand and learn their value."

Canada's Opportunity

The opportunities for research in the iron and steel industry—probably the largest of all the world's industries—appear unlimited. In Canada we have the mineral resources and the young industries, and the right type of young men to make a vocation of research work. I am not overlooking the older men, the trained scientists of to-day. No doubt we have in Canada at the present time as able scientists as there are in any other country in the world; but we must look to the young men to take their place and advance the field of Science. It may be safely said, that any young man entering the field of Science will be entering a field full of the finest fruits of nature.

We have the material in Canada, and if this fair Dominion is going to keep pace with other countries, we must have a strong, intelligent Government lead in the field of Scientific and industrial research, and hearty co-operation among our industries for the furtherance of the interests of each and all.

MOLYBDENUM STEEL ROLLS

In a recent issue of the *Blast Furnace and Steel Plant*, reference is made to the use of molybdenum steel rolls in rolling mills says the Foundry Trade Journal. These rolls are now being employed for the strongest roughing roll to the hardest finished roll. They are stated to be exceptionally tough, and will withstand long wear and tear.

Molybdenum rolls are estimated to give 200 per cent. increased service over carbon-steel rolls. It is believed that the use of these rolls will allow of a great increase in size of the entering billet, perhaps by as much as 30 per cent.

It is claimed that the introduction of molybdenum steel for rolls represents the greatest advance in the rolling mill practice that has taken place during the last 25 years.

Dayton Steel Foundry Co., Dayton, Ohio, have just purchased a three ton Moore Rapid 'Lectromelt furnace for their steel foundry. Their trade has enlarged to such an extent that their old furnace equipment will not take care of it and the company is improving its equipment in view of its larger business. The 'Lectromelt furnace now installed here replaces two furnaces of another make.

The Institute of Metals

AUTUMN MEETING IN SWANSEA, WALES

By ROLAND H. BRIGGS

The annual three days Autumn Meeting of the Institute of Metals was held in Swansea on September 20, 21, 22, and fifteen technical papers were read and discussed. The most important of these was the sixth report to the Corrosion Research Committee of the Institute of Metals on the nature of corrosive action and the function of colloids in corrosion, by Dr. Guy D. Bengough, M.A., D.Sc., and J. M. Stuart, M.A. A general consideration of corrosion phenomena was the basis of this report, drawn from the study of several different metals, and the electro-chemical theory of corrosion in its relation to the observed phenomena was examined. It was shown that corrosion can only be accounted for by electro-chemical action up to a certain point, and that the important part played by colloids must be recognised. A theory of the mechanism of colloid action was put forward.

Corrosion of Metals

Corrosion is defined as the oxidation of a substance, and such oxidation may be produced by chemical or electro-chemical means. Chemical reactions may occur when the reacting bodies are in contact, electro-chemical reactions when the reacting bodies are partially separated. In the latter case the reacting substances must be capable of ionization, and a portion of the energy of the system appears as electrical energy.

Cases of corrosion were considered that can be carried out chemically or electro-chemically. Pure electro-chemical action may in certain cases be relatively unimportant, the cathode of a cell of high voltage may be more rapidly attacked than the anode, while an anode at a high voltage tending to force it into solution may be very little attacked, owing to scale formation.

It is also difficult to see how the purely electro-chemical theory can explain the facts that certain depolarizers do not increase corrosion, but actually inhibit it, that the conductivity of electrolytes is not directly connected with the amount of corrosion, that Lambert's pure iron, probably the purest metal ever produced, was found to be readily attacked by sodium chloride solution and dilute acids, and that according to the electro-chemical theory the presence of ions of the corroding metal should depress the corrosion of most of the common metals, whereas the reverse is frequently the case. Scale formation interfere with electro-chemical action, and a main factor in determining the amount of corrosion by water and salt solutions is the nature and distribution of the products of corrosion.

The effect of strain in metal as assisting corrosion is of only minor importance, and while a trace of impurity appears to assist local corrosion, the amount of corrosion is not proportional to the amount of impurity. Even graphite does not appreciably stimulate the rate of corrosion of iron. Local action at metallic surfaces may be produced in various ways at any selected points by modifying the conditions external to the surfaces, and is not mainly determined by the presence of anodic areas on the metal.

Atmospheric oxygen has very little depolarising power at ordinary temperatures. The main function of oxygen in corrosion is to oxidise directly the metal and in some cases also the products of corrosion. The general type of corrosion, usually characteristic of acid corrosion, is distinguished from the local type, usually characteristic of corrosion in water and salt solutions. With the second type there is generally an adherent scale on the metal, and this scale may contain colloids.

Theory of Corrosion

The following theory was developed during this research. A metal in water sends positively charged metal ions into the liquid and becomes itself negatively charged. Ordinary commercial metals also become superficially oxidised if dissolved oxygen is present. The hydroxide produced by this oxidation can take up the ions given off by the metal, and the hydroxide passes into the state of a positively charged colloid. Some of this colloid diffuses, permitting further reaction between the oxygen and the metal surface, thereby re-forming the hydroxide film over the latter. Oxidation then stops until this hydroxide can pass into the colloidal state by acquiring positively charged metal ions. This generally takes place when the colloid initially formed has diffused into the electrolyte, when it is precipitated by the an-ion of the dissolved salt, the cation neutralizing the charge on the metal corresponding to that on the colloid. This allows the metal to send more ions into solution, and the uncharged hydroxide thereby acquires a charge. If the colloid so produced can diffuse, the process can continue and corrosion can develop.

Therefore for steady corrosion the colloid must be produced under conditions that allow it to diffuse some distance from the metal before precipitation. If it precipitates directly on the corroding surface it will, generally, adhere to the latter and stop corrosion. In the case of the corrosion pit the first condition is fulfilled, since no precipitation occurs inside the pit. It is only when the colloid diffuses through an aperture in the gel-deposits at the mouth of the pit, that it meets the electrolyte and is then precipitated. Such precipitation merely thickens the external gel-deposits. These gel-deposits adhere to and protect the metal surrounding the pit and thereby emphasize the local nature of the corrosion.

Analytical Method for Aluminium

A second important report read at the meeting was to the Aluminium Corrosion Research Sub-Committee of the Institute of Metals. This report, by J. E. Clennell, B.Sc., dealt with experiments on the oxide method of determining aluminium by analysis. It was desired to find a direct method of determining aluminium in the presence of iron and other impurities, and the phosphate and ammonia methods were rejected as unsatisfactory. Other methods were also tried, but a method was finally evolved whereby iron was practically eliminated and other impurities reduced to a minimum.

This method consists in passing sulphur dioxide through the slightly ammoniacal solution, precipitating in dilute, faintly acid, boiling solution with sodium thiosulphate, with the addition of dilute acetic acid, washing by decantat'on with hot 1 per cent. ammonium chloride, and filtering and washing with hot water. Iron, zinc, manganese and magnesium in ordinary amounts, do not interfere with the work, but when the first two are present in large quantity a double precipitation is necessary. The method was successfully applied in experimental work carried out for the corrosion research committee on the oxidation of aluminium amalgam.

Alloys to Withstand Superheated Steam

Another paper was read by Sir Henry Fowler, K.B.E., who described the effect of superheated steam on non-ferrous metals used in locomotives. Superheated steam is now generally used in locomotives, the steam usually leaving the superheater at a temperature of about 340 deg. C. The steam falls in temperature as it expands. The following metal mixtures for counteracting the effect of superheated steam are now used by the Midland Railway Company in England.

The piston tail rods broke in service and are now made of phosphor bronze, (copper 88 p.c., tin 11 p.c., phosphorus 1 p.c.), which is satisfactory. The white metal piston rod packing rings used were found to fuse, and packing to prevent the steam reaching the white metal is now used as follows, copper 75.5; tin 8.5; zinc 0.33, phosphorus trace, nickel 0.5, and lead 15 per cent. The piston valve fittings and cylinder relief valves have been made of copper 87, tin 9, zinc 2, and lead 2 per cent., and have acted satisfactorily, but the same alloy used for by-pass valves, which are subjected to shock, as also good quality cast-iron and also phosphor bronze, were unsatisfactory. A complex nickel-brass gave good service but owing to its cost was replaced by malleable iron or steel castings.

Three writers collaborated in a practical paper on white metals, A. H. Mundey, C. C. Bissett, B. A., B. Sc., B. Met., and J. Cartland, M C., M Sc. They dealt with the composition, mechanical and physical properties of the chief white metal alloys used in commerce, with special reference to anti-friction and bearing metals and metals for the type foundry.

Diffusion of Metal Grains

Professor J. H. Andrew, D.Sc., and Robert Higgins presented a paper on grain size and diffusion. Diffusion at high temperatures may take place simultaneously with grain-growth, while at low temperatures diffusion promotes a breakdown in the grain size, and these results have been applied to the annealing treatment of commercial castings. An explanation is given of the atomic arrangement existing at the grain boundary. In the interior of the crystalline grains the system of close packing holds, while at the boundaries the atoms in the separate grains touch only at one part of the circumference. Plastic deformation, by moving the atoms in certain grains from their position of equilibrium, will cause these atoms to rearrange themselves. When heated to a sufficiently high temperature, this arrangement will be so brought about that the stressed atoms will, row for row, fall in with the unstrained atoms of the adjacent crystal, thereby effecting a gradual migration of the grain boundary. Such a re-arrangement may proceed from every side of a crystalline unit, resulting in one grain being divided up and being absorbed by others. The final bounding surface will result when a state consistent with that suggested for the boundary configuration finally results.

Papers on Aluminium

A paper was read by Miss Marie L. V. Gayler, M.Sc., on the constitution and age-hardening of alloys of aluminium with copper, magnesium, and silicon in the solid state, and one on the copper-rich aluminium copper alloys by D. Stockdale, B.A. In a paper on the cleaning of aluminium utensils by Dr. R. Seligman, Ph.D., and Percy Williams, B.Sc., the writers showed that where a small quantity of sodium silicate is added to soda solution, it completely prevents the action of the hot soda solution on the aluminium, so that detergents consisting of soda and sodium silicate are suitable for cleansing aluminium utensils.

A paper of great interest to the aluminnium industry was read by Dr. W. Rosenhain D.Sc., F.R.S., and J. D. Grogan, B.A. who dealt with the effects of over-heating and melting on aluminium. A long series of experiments was carried out, commercial aluminium of the greatest obtainable purity being heated to high temperatures, repeatedly re-melted, and repeatedly rolled and remelted. The experiments gave no support to the belief that the deterioration known as "burnt" aluminium is due to excessive heating or re-melting. The investigators suggest that this deterioration is due to slight progressive contamination with other materials and not to re-melting.

F. L. Brady, M.Sc., dealt with the structures exhibited by eutectics, mainly those between metals and metallic compounds. A paper was read by Maurice Cook, M.Sc., on the antimony-bismuth system. A Jefferson read a paper on the cause of red stains in silver plated work, which he showed to be due to the indiscriminate use of rouge in the finishing and polishing processes, through the absorption of the rouge into the open pores of the heated surface, the heat being evolved by the friction of the hand or finishing "Dolly." Q. A. Mansuri, B.A., M.Sc., presented a paper on inter-metallic actions, the system thallium-arsenic.

Bottom-Pouring of Alloys

The meeting was concluded by the reading of two very important papers, the first of which dealt with some new forms of apparatus for determining the linear shrinkage and for bottom pouring of cast metals and alloys. The new shrinkage apparatus consists of a micrometer, the head of which is separated from the anvil. Both head and anvil are each fixed to a steel socket provided with a tightening clamp, which clamps on a moving arm. The two arms are guided by grooved vulcanite wheels which rotate freely on stationary spindles. Each micrometer arm is bent horizontally at a right angle and a sleeve fixed at the end of each by a set pin, and extension pieces bent at a right angle vertically form the legs of the apparatus and rest in the mould. The mould is water-jacketed.

The new apparatus was used in investigating the shrinkage and hardness of chill-cast copper-zinc alloys. The alloys were prepared in a separate coke-fired furnace and transferred thence to the new bottom-pouring apparatus, which has many advantages, including the control of the pouring temperature, the facility with which the temperature of the metal may be registered, the absence of delay between the attainment of the required pouring temperature and the release of the metal into the mould, the control of the rate of pouring, the exclusion of dross from the stream of metal, thus obvisting the necessity of skimming, and the mitigation of zinc-fume.

Brinell Hardness Experiments

In the final paper F. W. Harris, M.Sc., dealt with some experiments he has made on the hardness of the brasses, and the measurement of this hardness by means of a strainless indentation. The writer showed that in measuring hardness with a Brinell or similar machine there may be an error because the action of making the impression causes a rapid accumulation of strained and consequently hardened material in the immediate vicinity of the

impression. As it is not commercially feasible to measure hardness by just failing to make an impression, the writer shows that the desired result can be brought about in another way, namely by removing the strain by annealing and by replacing the ball in the original impression and replacing the load. After several repetitions of this process a point will be reached at which the ball will be able as it were to float in the impression under the pressure of the load. The material will then be supporting the load by virtue of its own elasticity.

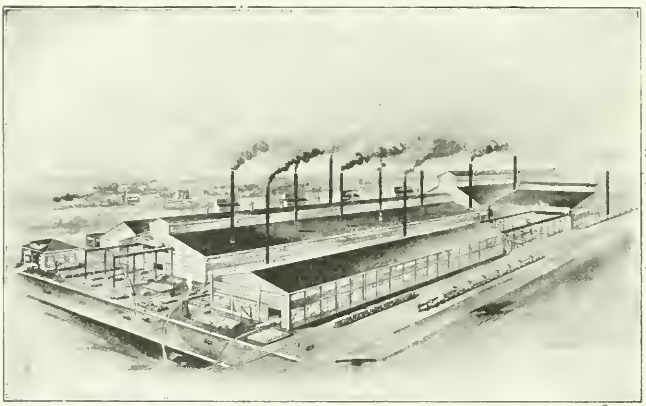
In the experiments carried out the theories generally advanced with regard to the connection between hardness and internal constitution were in the main substantiated, but there were certain anomalies which can only be explained by adopting a modified idea of the existing constitutional diagram.

Where 40,000 lb. Forgings are Made

Here is a brief description of a Canadian plant engaged in the production of special lines of forgings.

The Canada Foundries & Forgings Ltd. own and operate the Canada Forge Plant at Welland and a Drop Forge Plant at Welland.

The Canada Forge Plant was built in 1907 to take care of flat hammer forging requirements in the Dominion of Canada. The business has increased until to-day they are the largest forging plant of this type in Canada. Of particular interest to the iron and steel trade is the fact that they manufacture forge shafts of any size and can furnish these either smooth forged, rough, machine turned, or finished to blue print. Single forgings up to 40,000 lbs. in weight have been turned out by machines in that plant. Machine facilities in this plant are second to none. In addition to pulp mill forgings they are equipped to produce marine forgings, railway axles, dredge equipment, forgings for hydraulic machinery, locomotives, metal work machinery, mining and rolling mill equipment.



Welland Plant Canada Foundries and Forgings

They have made a specialty of forging steel balls for reduction of ore in the Canadian mines. This plant was one of the first and largest producers of shell forgings throughout the entire course of the war and occupied a prominent position in supplying of marine forgings during the shipbuilding time, making shipments to the United States as well as to the Canadian market. The Canada Forge Plant, notwithstanding the recent depression in business, has been operating continuously and at the present time have a larger volume of business on their books than they have had for some two years.

Their Drop Forge Plant is also situated at Welland, this plant is a factor in the supplying of automobile forgings for the various large manufacturers of automobiles in the Dominion. Such forgings as front axles, chank shafts, and third arms are produced in large quantities.. In addition to general commercial drop forgings they produce a line of staple forgings such as Turnbuckles, Engineers' Wrenches, etc.

In addition to the two plants at Welland, the Canada Foundries & Forgings Limited own and operate the James Smart Plant at Brockville, where for over half a century builders hardware and tools have been turned out.

Officers of the Canada Foundries & Forgings Limited are: —

Hon. Geo. P. Graham, Brockville, President
W. M. Weir, Montreal, Vice-President,
James Arnold, Brockville, General Manager
J. H. A. Briggs, Brockville. Secretary-Treasurer.

India is becoming rapidly an important factor in the iron and steel trade of the East. Japanese manufacturers are now feeling the effect of Indie's competition in Japan.

During September 5203 tons of pig-iron was exported from the United States. Of this over half, or 3768 tons, came to Ontario and Quebec.

Where Profit Begins

By A. R. R. JONES, Editor, Journal of Commerce

Consider the balance sheet. There you find two exceedingly significant words, Profit and Loss, one on either side of the heavy line down the center. What does the balance sheet tell? Ordinarily we think of it as telling whether we are better off at the end of the period considered than at the beginning. For most people, this information is quickly got by looking at the family check book, or perhaps in the purse behind the clock in the kitchen, together with a glance at the bills on the back of the cupboard door. For others it means considering the instalments paid on home or furniture, or, perhaps, amounts borrowed on insurance policies to pay income tax. For business organizations the balance sheet is often complex, but the last line is always simple and easily understood. If it is in black ink, well and good; if in red ink, call the doctor—or the undertaker. Red is the universal danger signal, whether it be a red nose or a red flag—or, red ink.

In the case of the balance sheet, red ink means "a loss." Now a loss is a double calamity. It means that over the next period it will be necessary to make up some ground before progress begins, and that further ground must be covered in order to get to the place that should have been the new starting point. "Holding your own" may be a good motto for a bull dog, but it is a poor excuse for men in business. Variety may be the spice of life, but progress is the life of business. Progress means employing more men, giving them better wages and better living conditions, producing more goods and better goods, and rendering greater "service". Profit makes this possible, and the serving makes life happy and worthwhile.

A glance at the balance sheet shows that losses must be overcome before there is any profit. Sometimes a balance sheet shows a profit that is not there, not because the profit side is padded, but because the loss side is not complete. The items of loss have two principal elements, quantity units and unit cost. The quantity units apply to material, power and time (labor). Unit costs apply to each, which may yet be divided and subdivided until a point is reached where the possible loss in cost of material or operating time would be less than the cost of keeping the record. But even if complete account is not kept of each item of possible loss, it is necessary to know the danger is there. Locating and stopping losses can only be complete, or even approximately so, when every man in the mill is aware that he has a personal interest in the matter.

The Technical men have been giving a lot of attention to matter of material losses, but we feel that the man on the job doesn't realize what a leak in a steam pipe, or the use of too much alum, or a thousand less obvious things mean, until he sees it in dollars and cents, and realizes that his own employment is insecure if the losses exceed the profits, because he and his fellows have not stopped every possible leak. He must realize also, that all on the profit side is not "velvet." There are bound to be lean years when there is little or no profit, yet he is kept on the pay roll and given something to do. Experience shows that most men will not make provision for idle time, and if such provisionn is to be made, every man must help make it possible for the management to build up a reserve that can be drawn on in times of adversity to hold things together.

The thing a man fears most is loss of his job. Except for accidents due to personal carelessness, or because of personal inefficiency or insubordination, men are usually out of work because losses have exceeded profits till the firm is "busted." The plant is shut down.

It may take some time for the crisis to develop, but we feel it can safely be said that the trouble usually originates in an inadequate conception and knowledge of costs, and particularly of the costs of losses.

There are some kinds of loss common to all industries, such as heat, power, materials and labor. These are lost in various ways, and each industry has its own peculiar ways of throwing money away. It may be heat units in flue gas or escaping steam, lack of proper lubrication on a bearing, using a wheelbarrow instead of a gravity conveyor, sending wool grease down the sewer, or letting fungus destroy a pile of pulpwood. In most cases it is lack of education of the individual workman in the value of losses and an inspiration of his desire to put every available cents worth of time and material into his firm's product. Many a man will smile at a ton of pulp going down the river who would protest vigourously if he found a potato in thegarbage can. Every man can save something, somewhere. Show him how and why.

We are entering a period of prosperity. It is now possible to lay aside a reserve for idle time; it is absolutely necessary to do so. This provision cannot be made fairly nor correctly unless done scientifically. A cost system need not be elaborate, but it must be adequate to the business and must have the support, so far as is needed, of every employee in the works. Why not get busy now and prepare for a possible period of part time operation? Get a reserve to take care of the overhead on the idle machinery and men. Base prices on costs of actual productive operations and proportionate overhead. With costs properly ascertained, there will be less throat cutting, closed factories and idle men where the next pinch comes.

Nickel Chrome Steels

REPORT OF LECTURE BEFORE STAFFORDSHIRE IRON AND STEEL INSTITUTE

By ROLAND H. BRIGGS

An interesting evening was spent by the Staffordshire Iron and Steel Institute on November the 18th. in the consideration of a paper by Mr. T. Henry Turner, M. Sc., Assistant Lecturer and Demonstrator of the University of Birmingham. (England.) The paper was of a very practical nature, dealing with experiences in the use of Nichel Chrome Steels in one of the greatest of British engineering works, and in tests and investigations made on this metal connected with failures in practice.

The material examined consisted of large and medium sized forgings received for machining. The failure of a nickel chrome steel part in service is generally of more serious and far-reaching consequence than is that of a straight carbon steel, because the nickel chrome steel will have been chosen by the designer on account of its special strength, and because the part in question will have been designed to be stressed more highly than is usual with parts made of carbon steels. The increased efficiency of modern machinery has almost invariably been gained at the expense of higher speeds, lighter parts and greater stresses per square inch at the material employed, and it is not surprising that nickel chrome steels have failed at times, since higher speeds have frequently brought vibrational stresses, the nature of which could only be calculated with difficulty.

Inspection after Machining shows Defects

In the works in question, all highly stressed parts are very carefully scrutinised. In this way one or two faint markings on the machined surface of a hollow cylindrical bell, roughly 3 feet in diameter, 1 foot high and 3 inches thick were seen. These marks ran in almost straight lines nearly the whole length of the cylinder. Eight marks almost exactly spaced and parrallel were found, and their position coincided with the corners of the original octagonal ingot mould from which the steel had been taken for forging. Further forgings had exactly similar defects.

A very interesting feature of these defects was that they were only visible immediately after machining. Even with the assistance of lines which had been drawn on each side of the defects to mark them at the time when they were first located, it was impossible subsequently to detect any trace of the lines of segregation on the slightly tarnished surface. Etching with nitric acid made no improvement and it was necessary to file up the surface and take a sulphur print before it could be demonstrated that any lack of homogeneity existed. Yet these planes of segregation extended from two to three inches into the forging.

Recommendations to Provide Against Failures

A very careful microscopical examination was carried out of sections cut from the cylinder and exhaustive mechanical and physical tests were also made. From the results and information obtained in this investigation it has been found possible to formulate the following recommendations. The bell-shaped cylinder design should never be used unless the supplier can guarantee absence of planes of segregation in the material and adequate working during the forging operations. Where the supplier cannot guarantee adequate working of the material during forging, (owing to the nature of the design and the limitations imposed upon his work by the nature of his available tools,) a composite ring made up of two or more rings, which can be manufactured by a satisfactory forging or rolling, would probably prove more reliable.

The final rolling of such rings is to be preferred to forging them throughout, as it tends to produce uniformity of dimensions in the rough, and therefore economy in machining. It should also produce a better and more uniform internal structure, and greater uniformity of mechanical properties. With all large forgings subjected to appreciable circumferential loading, the supplier should be asked to face up both ends of the block of steel before forging is commenced. Sulphur prints should then be taken and forging only proceeded with after these have been passed as satisfactory. Where this is considered impracticable, the elimination of ingot corner segregation may be achieved by forging down octagonally and machining off the corners which would still contain the segregation. The centrifugal casting of steel for such large cylinders or rings, and even for large turbo-generator rotors, is feasible and worthy of serious consideration.

Defects due to Ingot Corner Segregation and Local Heating and Cooling

The rejection of the forgings in the particular case described was fully justified, because, although the mass of the material possessed good chemical and mechanical properties, the planes of segregation entirely negatived these good properties, and made the forging as a whole treacherous and unreliable in the extreme. Ingot corner segregation is a defect to watch for.

In a particular type of highly stressed nickel chrome forging used in an electrical machine, a series of failures occurred which were apparently due to the brittle nature of the material. A careful investigation of the material, near the fracture, however, showed that the failures were due to the effect of local heating upon the sensitive alloy steel.

A very careful examination is also made of all disc forgings used in the Works previously referred to, and in one case several nickel chrome discs, about six feet in diameter, were found to contain minute hair cracks round a raised boss forged on one side. A most careful examination revealed no other flaws, one disc being entirely machined away under careful observation during these tests. In each disc the cracks occurred on the shoulder of the raised boss. During forging this side of the disc had been continually on the anvil and cracking must have been due to a combination of stresses, but principally to the cooling effect of the anvil and to the lack of work upon this side of the forging. Such fine cracks are very difficult to detect. They are probably harmless in static loading but dangerous in the extreme when in combination with alternating and vibrational stressing.

Next to character, a new idea is the most valuable thing in the world. A new idea is something that anyone, rich or poor, young or old, can get. Every progressive employer will cheerfully pay for a new idea The best way to get an increase in salary is to bring your employer a new idea. New ideas are the only things that have made money for me; new ideas are what every one makes money with. I have yet to hear of a person who carried a good idea to his or her employer and did not get rewarded for it. All of us can cash in something on every worth-while new idea.

—Roger W. Babson.

New Forge Blower

GIVES NEW MEANING TO TERM "FREE AIR"

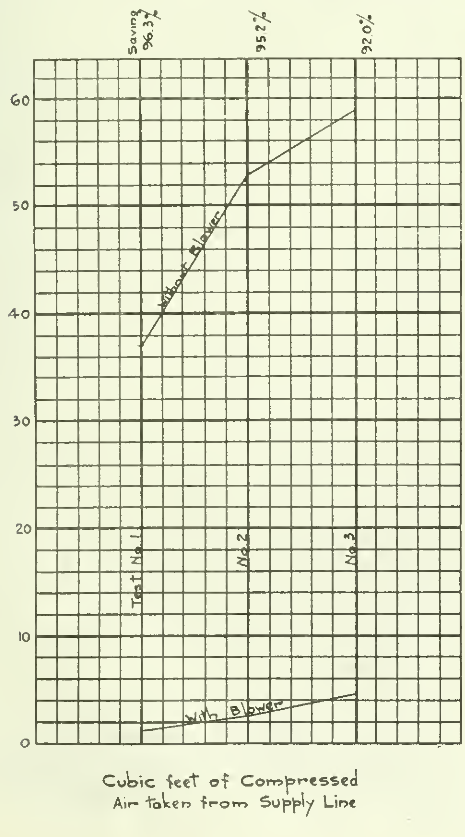
by D. M. McLean, E. I. C.

Iron and Steel mill executives, structural steel fabricators, boilermakers, foundrymen, mine operators and others will undoubtedly be interested in a new device for blowing forge fires, etc., that has recently been introduced in Canada by The Canadian Ingersoll-Rand Company.

A tiny jet of high pressure air discharges into a bell-mouth nozzle leading to the forge and induces a flow of air from the atmosphere into the nozzle where it mingles with the expanding jet and is propelled into the pipe leading to the forge, providing the proper volume of air at a suitable pressure for the purpose.

In present practice in steel plants, boiler shops, blacksmith shops, mines, quarries, shipyards and certain chemical processes, it is customary to take compressed air from the general supply line and throttle it down to a pressure of a few ounces before it reaches the forge fire or other point of use. In rivet heating, for example, the ordinary small portable forge will require about 45 cubic feet of free air per minute to blow the fire. To compress this to the initial pressure of 100 lbs. will take the expenditure of approximately 7-½ horsepower. In constant daily use, this may mean a yearly cost for air for one forge of at least $300.

With the new blower or air transformer described herewith, the consumption of compressed air from the supply line is less than 2 cubic feet of free air per minute, requiring practically one-third of a horsepower, because the other 43 cubic feet required for the fire is drawn direct from the atmosphere. This represents a saving in dollars and cents per year per forge, other



Cubic feet of Compressed Air taken from Supply Line

Fig. 2.
Forge Blower in Use

conditions being equal, of not less than $275. per forge. The term "free air' therefore, takes on a new and very important meaning.

The chart, Fig. 1 shows graphically the results of three tests of forges operating with and without the blower. The space between the upper and the lower curves indicates the greatly lessened drain upon the compressed in percentages at the top of the cut.

Test No. 1 was taken with a slow fire, No. 2 with a fairly hot fire and No. 3 with an intense fire. These percentages may also be considered as expressing the efficiency of the blower under the varying conditions, and they emphasize unmistakably the futility of the common practice of compressing the required quantity of air to a pressure of 80 to 100 lbs. and then throttling it down for use at a pressure of a few ounces.

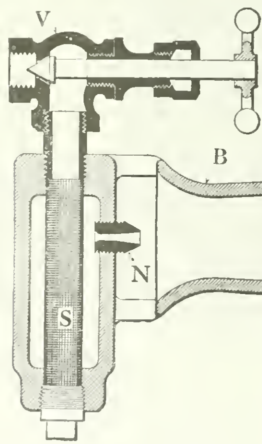
These tests were taken with practical needle valve openings and consequent reduced pressure on the jet nozzle. The results of tests with the blower connected to an orifice tank with low pressure nozzle on the outlet to furnish resistance to draft and measure the output are shown in the tables apprended.

Fig. 3 shows the general arrangement of the device. V is an ordinary needle valve regulating the flow of

compressed air. In ordinary operation, one quarter of a turn usually provides sufficient air for the work. After passing through the strainer S which retains all dust and dirt which might clog the device, the air reaches the special nozzle N and is discharged into the bell-mouth B which is connected to the forge.

The bell-mouth is cast solid with the strainer chamber, and ample space is provided for the access of free air as it is drawn into the bell-mouth. The strainer may easily be blown out to clean it by removing the plug at the bottom of the chamber. Homemade blowers resembling this device have often been made up from pipe fittings, but cannot attain anything like the result reached by this specially designed appliance, proportionated and adjusted for the best possible results. The standard blower of this type is designed to deliver the air at a pressure of 4 inches of water, but higher pressures may be reached by the use of specially designed jet nozzles.

In the tests mentioned above the actual air pressure in the screen chamber below the needle valve was taken. This is the same as the working pressure on the jet nozzle. The cost of this device is such a small fraction of the saving it ensures that it may be expected to have quite a wide application in its particular field.



F.g. 3.

TEST No. 1.

RESULT OF TESTS OF NEW JERSEY BLOWER ON WIND BOX USING 1" ORIFICE

Working Pressure on Jet Nozzle lbs. per sq. inch.	High Pressure Air Used C. F. F. A per minute.	Low Pressure in inches of water	Free Air delivered C. F. M.	% of Air Induced
5	.96	.31	12.15	92
10	1.36	.72	18.5	92.8
15	1.67	1.00	21.8	92.3
20	1.93	1.25	24.4	92.2
30	2.52	1.84	29.6	91.5
40	3.07	2.38	33.6	90.8
50	3.64	2.87	36.9	90.2
60	[illegible]	3.14	3.86	89.2
70	4.75	3.61	41.4	88.7
80	5.3	4.12	44.2	88.
90	5.85	4.57	46.5	87.5
100	6.15	5.05	49.0	87.

With a 1" Orifice the New Jersey Blower develops pressure or draft in excess of ordinary requirements for blowing forges. When pressures or resistance against which the Blower delivers is increased, this is at the expense of volume and also reduces the percentage of free air induced. The normal outlet of the Blower is 1¼" giving a greater volume at a little lower draft pressure.

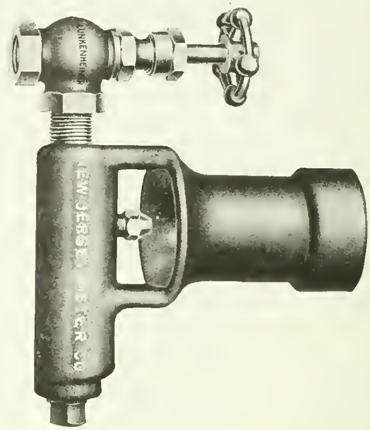


Fig. 4.

TEST No. 5.

RESULTS OF TESTS OF NEW JERSEY BLOWER ON WIND BOX USING 1¼" ORIFICE

Working Pressure On Jet Nozzle lbs. per sq. inch.	High Pressure Air Used C. F. F. A. per Per minute	Low Pressure in inches of water	Free Air delivered C. F. M.	% of Air Induced
5	.96	.29	18.3	94.8
10	1.36	.48	23.6	94.5
15	1.67	.67	28.0	94.0
20	1.93	.88	3.19	94.0
30	2.52	1.29	38.6	93.5
40	3.07	1.64	43.5	93.0
50	3.64	1.95	47.5	92.4
60	4.20	2.18	50.5	91.7
70	4.75	2.50	54.0	91.4
80	5.3	2.80	57.0	90.6
90	5.85	2.95	58.5	90.0
100	6.45	3.25	61.4	89.5

The resistance to flow or draft pressure required in an ordinary forge is somewhat less than for a nozzle of this size. With less resistance the flow is greater in volume. The working pressure on the jet is controlled by the needle valve and can be anything up to the full line pressure. In forge blowing the working pressure required is usually from 15 pounds and draft pressures of ½" to 1".

In addition to its utility as a forge blower this device is also suitable for use wherever a small volume of air under low pressure is desired.

In spite of competition at home that precludes the sale of her output of high-grade iron and steel there, the Swedish production is increasing. This is due to the world-wide demand for material of the well-known Swedish quality.

Book Reviews

IRON ORE — Part 7 — Foreign America — Imperial Mineral Resources Bureau — 4s. 4½d., post free, from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2 — 136 pages.

This volume describes concisely the iron ore deposits of both Americas, with the exception of the British dominions and colonies, which were dealt with in Part 3. The chief producing country is, of course, the United States; but Cuba and Brazil have deposits of the first magnitude, in which development has been commenced, and a number of the South American republics have large, though mainly unexplored, supplies of high grade ore.

The main facts of the iron-ore situation in the United States are so generally known that there is no need of repeating them here. It is noted once more that the high-grade ore of the Lake Superior field will last for only a few years, and that, if this field is to keep its ascendency, commercially successful process of "beneficiation" for low grade ores must be developed. The alternative to this is an enlarged use of the huge deposits of Alabama and the development of scattered deposits throughout the western and northeastern states.

That the growth of the United States steel industry has been developed for, and rests upon, the home market is made clear by the fact that exports of iron and steel are almost a negligible quantity, except during the abnormal war period. The United States does not influence seriously the British export of iron and steel. The former point has a moral for Canadians. We also have a huge territory in Alberta, protected by natural barriers from outside sources or supply, in which it may be possible to effect a successful industrial development alongside the great agricultural development that is now in prospect.

Cuban ore, though cheaply mined and transported, is not as yet used in great quantity. It has been used principally for the manufacture on the United States Atlantic seaboard of iron and steel for export. It is estimated that 1,000 million tons of commercial ore is available.

Mexico has numerous important deposits of iron ore, but only a small production. A development of deposits on the Pacific coast is forecasted.

In the Minas Geraes district of Brazil, superficial examination has determined the largest known reserve of high-grade hematite known in the world. A large part of the several thousand millions of tons available is almost pure oxide of iron, the silica being less than one per cent. and phosphorus and sulphur well below working limits. It is noted though, that the phosphorus is higher than is commonly supposed. The absence of coal has prevented the establishment of any important iron and steel industry. The government of Brazil wishes to encourage the home production of iron and steel, and an attempt to establish an electric smelting plant is under way.

Of the resources in iron ore of the other South American republics, little is known. Nowhere is coal available in sufficient quantity to stimulate a search for iron ore. Deposits have been found in all, particularly in Chile, where the high grade and accessibility of some of the ore has stimulated an attempt to establish an electric steel plant at Santiago.

IRON ORE — Part 8 — Foreign Asia — Imperial Mineral Resources Bureau — 2s. 9½d., post free, from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2 — 79 pages.

So far as determined up to the present, Asia is the least bountifully supplied with iron ore of all the continents. The principal known deposits are in China and Manchuria, and important ore-bodies have been located in the Philippine Islands, as well as those in Japan and in Korea, now part of the Japanese Empire.

The various iron ore deposits of China are estimated to contain 1,000 million tons. A large part of this is in the Yang-Tse valley, adjacent to the best coal to be had in eastern Asia, which is controlled by British capital. About one-half the known iron ore supply of China is now controlled by Japanese firms, which have been mainly responsible for the considerable growth of the iron and steel industry of north China during recent years.

The present annual consumption of iron per capita in China is less than 0.008 ton. In the United States the figure is 0.25 ton. It is expected that the consumption per annum in China will increase rapidly during the next few years. If it were to reach the United States figure per capita, the known ore would last only five years.

Japan has ore reserves totalling 80 million tons. Most of her annual supply is brought from China, where she controls half the reserve available, as mentioned above. In spite of the disabilities due to poverty both of ore and of fuel, Japan is forging ahead as a producer of iron and steel.

In the Philippine Islands, in Sangao province, an area of 40 square miles along the coast contains lateritic ore of good quality, totalling 430 million tons. The nearest market at present in Japan, to which transportation is economically available.

In eastern Siberia, it is known in a vague way that immense deposits of iron ore occur, none of it being developed as yet. Throughout the rest of Asia, iron ore is widely distributed, but little is known of its economic possibilities.

IRON ORE, PART 6 — FOREIGN EUROPE AND AFRICA. — Imperial Mineral Resources Bureau— H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2 — 275 pages — 6s. 5½d. post free.

This volume, the last of the series on iron ore to be published, is particularly concerned, of course, with the well known minette ore beds of Lorraine and the magnetite ores of Sweden, Europe's chief sources of supply outside of Britain, and the relation of these to the British supply. In terms of iron content, France has 36 per cent., Britain 23 per cent. and Sweden 11 per cent. of Europe's known reserves. Britain's ore has a lower content in iron than the other two, but enjoys the advantages of abundant coal and sea transportation within easy reach.

In spite of their low content of iron (rarely reaching 37 per cent.) the minette beds of Lorraine constitute the most important single source of iron in the

world at present. Their central position in Europe gives them a value that corresponds to that of the Lake Superior deposits on the North American continent. A self-fluxing mixture of various kinds of ore from these beds is used. Elsewhere in central Europe the deposits of iron ore are characteristically of comparatively small dimensions and high in silica.

Since losing Lorraine, Germany's principal resource in iron ore is high-grade siderite, high in manganese, found in veins in the Siegerland district of Westphalia, and siliceous hematite occurring in sedimentary beds to the south in the Dill and Lahn basins. Though these are only of second-rate importance, Germany's control of the Westphalian beds of coking coal assure her of a position of prime importance in the world's iron and steel trade.

Italy has no coal, but has blast-furnaces on the island of Elba, where important deposits of iron ore occur as veins and lenses. In Piedmont electric furnaces are used extensively to treat ore from the Val d'Aosta.

The ores of Norway consist mainly of low-grade magnetite requiring concentration. In Sweden, on the other hand, there are in addition numerous deposits of high-grade magnetite, which have been described fully on various occasions.

Russia has numerous and important deposits of iron ore, most of these being in South Russia and the Urals. At present the iron ore industry is at a complete standstill.

Spain and Portugal have important deposits of iron ore, but the latter is unexplored, in the main. The Spanish ore is characteristically high-grade hematite. Much of this ore is convenient to sea-ports, and is shipped abroad, notably to Britain. Coal is available conveniently and in abundance ,and Spain's iron and steel industry is growing rapidly.

Though iron ore is known to be abundant and of wide-spread occurrence throughout the continent of Africa, it has been worked to any extent only in Algeria, whence considerably amounts are shipped to smelters in France.

* * *

In concluding these notices of the admirable series of volumes published by the Imperial Mineral Resources Bureau, we have only one suggestion to make. It is that, at slight additional expense, a competent draftsman could be employed to make maps to illustrate future —orts that would be more in keeping with the high ality of the text.

VANADIUM, (1913-1919) — Imperial Mineral Resources Bureau — 7d., post free, from H. M. Stationery Office. Imperial House, Kingsway, London, W. C. 2 — 19 pages.

This little report gives a resumé of the uses, preparation and occurrences of vanadium and its ores, with special attention to occurrences. The ever-increasing use of this rare metal to improve the quality of steel gives it an interest that is in proportion to the growing use of high-grade steels. Though the amount of workable ore available is small, vanadium is required to be added to steel in such minute quantities (0. 2 to 1.5 per cent.) to produce its whole effect that no large annual tonnage is needed. Its action in "scouring" steel by removing nitrogen and oxides as well as its direct alloying action are still the subjects of much study.

The chief, and at present almost the sole, source of commercial supply of vanadium is the Misasagra patronite deposits near Cerro de Pasco in Peru. The vanadiferous asphalt of these deposits when roasted to eliminate sulphur and carbon contains over 50 per cent. vanadium pentoxide. The next most important source of vanadium is the district in Utah and Colorado in which occur carnotite an ore of radium and vanadium, and roscoelite, the vanadium mica. These deposits, now owned by the Vanadinm Corporation of America as are the Peruvian deposits, are not now being operated.

In the British Empire, vanadium ore is widely distributed, but has been found only in relatively unimportant amounts, mainly in conjunction with deposits of lead ore. At Broken Hill in Northern Rhodesia, hand-picking from the lead-zinc ore provides high-grade vanadium ore as a by-product. At Kaffirskraal in South Africa a deposit of vanadinite of fair size has been delineated. In South-West Africa in the Otavi district there has lately been a small but consistent production of mottramite from scattered deposits. In South Australia, carnotite occurs with titaniforons magnetite near Olary. An attempt made to use the deposit as a source of radium has been unsuccessful. The Taranaki iron-sands of New Zealand contain vanadium up to 0.34 per cent.

NICKEL (1913-1919) — Imperial Mineral Resources Bureau—H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2. — 56 pages. Price 1s. 7½d. post free.

This little review of the nickel industry, though naturally it can add little to the comprehensive report of the Royal Ontario Nickel Commission in 1917, gives some items of information that are not generally known. The present prominence and future promise of the Katanga copper mines in the Belgian Congo give weight to the statement that the blister copper contains about three per cent. of nickel and cobalt. Nickel is recovered from the electrolytic refining of blister copper in Japan, and the recoverable amount of nickel in the blister copper produced in the United States is about one pound of nickel per ton of copper — no small amount when one considers the annual production of copper in the United States.

The possibility of using the iron in the nickel ores of Sudbury is referred to briefly. "The Sudbury ores contain about 40 per cent. of iron. In every million tons of ore treated, 400,000 tons of iron, equal to one-half the Canadian production of pig-iron, is slagged in the furnaces and lost."

It is stated that pure nickel is malleable, and that the Mond process produces nickel that is 99.8 per cent. pure. This is, no doubt, the basis of the Mond Nickel Company's new malleable nickel plant at Clearfield. Pennsylvania.

The report is concluded by a bibliography, ten pages in extent, that includes references up to the end of 1921.

It is understood that the South Manchurian Railway Company, which is closely allied with American interests, will proceed with their plan for the erection of a large steelworks in the East. Co-operation with a Jepanese company, the Penchihu Colliery and Steelworks, is mooted. There is a rapidly expanding market for railway steel, and indeed all varieties of iron and steel products, in China and the republics to the north and northwest.

Goldie and McCulloch Company, Ltd.

A LONG ESTABLISHED CANADIAN FIRM

Of the many flourishing industries in Galt, that of the well known and long established firm of Goldie and McCulloch Company, Ltd. is second to none in importance.

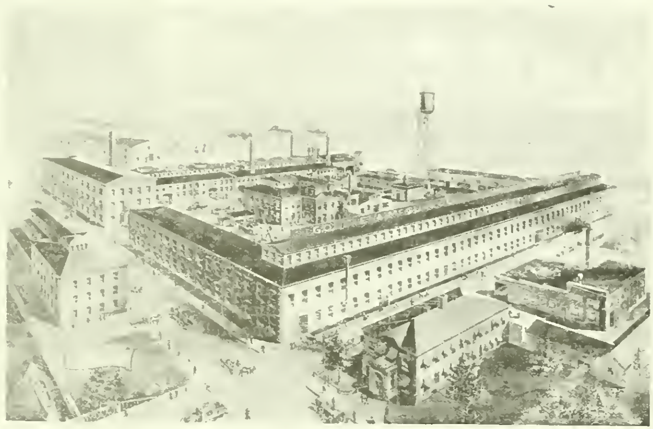
The original shop was started by James Crombie and moved to its present location in 1844, at which time the lines of manufacture included thrashing machines, flour mill work, steam engines and general repairs.

The first steam engine made by Mr. Crombie was installed in a sawmill at Roseville some time previous to 1850.

purchase their worldly capital consisted of about twenty-two hundred dollars each.

The Shop at that time consisted of a machine shop 40x60ft., two storeys, the moulding shop with a carpenter shop above machine shop and small blacksmith and boiler shops.

Twenty-two men were the total nmber employed, including Mr. Goldie and Mr. McCulloch. Mr. Goldie acted as foreman and shop manager, while Mr. McCulloch did traveling and finance work, with the help of an occassional bookkeeper.



The Works, Galt, Ontario,

of Goldie and McCulloch, Ltd.

Mr. McCulloch started working for the Crombie Shop in May, 1851, at a wage of one dollar per day.

Mr. Goldie started about 1854 and left again in 1857 to go into a sawmill at Acton.

Mr. Goldie and Mr. McCulloch bought out the Crombie Shop on August 8th, 1859, at a cost of approximately fifty thousand dollars. At the time of the

Until 1863 the business was conducted along the same lines which had been followed by Mr. Crombie. In this year however, they undertook to handle a contract for the Hamilton Rolling Mills, consisting mainly of rolling mill equiment. The contract was for sixty thousand dollars, a very large one at that time for two young men to undertake. Both members of

the young firm were exceedingly backward about submitting tender, which, however, they finally did and were successful in securing the order.

The first enlargement of any account was made in 1866, when a two storey section was put on the west end of the machine shop.

In 1867 the firm took up the manufacture of woollen mill machinery and in the following year the first wood planer was built and shipped to the Kribs Mill in Hespeler. The present safe shop, blacksmith shop and a portion of moulding shop were built in 1883, the paint shop having been built in 1881.

On January 1st, the first safe, which was for J. Hart & Co. of Toronto, was made, and the same year the first vault door was made. The following year, on Feb. 20th, the first banker's safe was shipped to the Maritime Bank.

Enlargements and changes in the personnel have taken place from time to tim,e until at present the two plants, North and South Works, occupy a very important place among Canadian industries. The present average number of employees runs from five to six hundred, and the present products consists of steam engines, steam turbines, reciprocating and centrifugal pumps, heaters, tanks, stacks, return tubular and water tube boilers, safes, vaults, vault doors and safety deposit boxes, with sons of the original owners in control, Mr. R. O. McCulloch occupying the positions of president and treasurer, while Mr. A. R. Goldie is vice president and general manager.

A reference to wages may be interesting. In 1864, at the time of the opening of the Hamilton Rolling Mi ls, the highest paid man in the shop received one dollar and twenty-five cents per day.

An interesting fact which should be mentioned is that the first engine built by the original members of the firm was installed by Mr. McCulloch personally and was moved to the plant of Charles Barber & Sons, Meaford, Ontario, where it is still in operation, and so far as we know giving good service. In all these years (in neighbourhood of 64) this engine has only been shut down once for any serious repair, at which time the cylinder was rebored.

CANADIAN ENGINEERING STANDARDS ASSOCIATION

The semi-annual meeting of the Main Committee of this Association was held November 13th, in Ottawa, at the Offices of the Association, Mr. H. H. Vaughan in the Chair.

After the transaction of formal business, the Secretary reported that the membership of the Association as of October 1st was 285, all members taking part in the work of various active committees of the Association.

Progress reports of the various working committees were presented, and it was announced that the Specifications for Steel Highway Bridges, Incandescent Lamps, Watthour Meters, Wood Poles for Transmission Lines, Flexible Wire Rope and Strand for Aircraft, and Commercial Bar Steel are well advanced or are ready for publication, that for Steel Highway Bridges being in the press. The Specification for Flexible Wire Rope and Strand for Aircraft was approved for publication.

In conformity with a request from the Secretary of State's Department, a formal resolution was passed changing the location of the Head Office of the Association from Montreal to Ottawa.

The Secretary's Report on the activities of the Association during the past six months was received and approved.

The personnel of a Sectional Committee on Road Materials and Construction under the Chairmanship of Mr. A. W. Campbell, Dominion Commissioner of Highways, was approved, this committee including representatives of all the Provincial highway authorities and having as its principal object the obtaining of Dominion-wide agreement on nomenclature, definitions and tests for road materials; and co-operating with the Committee recently appointed by the Engineering Institute of Canada on Road Construction.

A request having been received from the American Engineering Standards Committee for Co-operation in unifying divergent local requirements for the traffic Signals on Highways, it was decided to request the highway departments of the nine provincial governments, the Board of Railway Commissioners the Canadian Automobile Association and other bodies interested in automobile work, the larger cities of the Dominion, the Engineering Institute of Canada, and the railway authorities to nominate members on this Committee. The functions of this Committee will be to make a survey of present conditions in Canada, prepare recommendations accordingly, and consider these in connection with the draft suggestions to be prepared in the United States and forwarded by the American Engineering Standards Committee.

It was decided to take similar action in connection with a request for the Association's co-operation in connection with Specifications for Electric Overhead Crossings, the organizations interested in this case being the Board of Railway Commissioners, the steam and electric railway authorities, the power companies, and various power commissions, the provincial governments, and the various telegraph and telephone companies.

A suggestion from the Sub-Committee on Concrete and Reinforced Concrete that action should be taken looking to the preparation of specifications for Reinforced Concrete Poles was approved.

The Secretary reported that a number of favourable and some unfavourable replies had been received to the invitation sent out by the Honourable Mr. Robb, Minister of Trade and Commerce, for an interprovincial conference to be held under the auspices of the Association regarding the possibility of obtaining Dominion-wide agreement as to the requirements for the design, inspection and installation of electric fittings, appliances and equipment, and it was hoped that the conference in question would shortly be held.

The cost of experimental research on a commercial blast-furnace is prohibitive, due to the enormous investment required to build a single stack and its perquisites and the cost of a "freeze-up" which would inevitably attend effective experimental work. Still, the reactions in the blast-furnace are far from perfectly known, and a full knowledge might be of incalculable value. Consequently the United Sates Bureau of Mines has erected, at its station in Minneapolis, a small blast-funace in which it is hoped to conduct a thorough research. It has been tried out recently and has been found to simulate very satisfactorily the operation of the full-sized stack.

Raising Standards of Steel Castings

THROUGH JOINT RESEARCH

MAJOR R. A. BULL, Research Director of Electric Steel Founders' Research Groups

Presented at a Meeting of Division of Engineering, American National Research Council

Major Bull in an informal way explained the plan that has been followed by the Electric Steel Founders' Research Group. An abstract of his remarks follows:

The companies associated in this cooperative research work are in the strictest sense competitors, and manufacture steel castings, the metal being made in electric furnaces. The plants all specialize in making castings of small size and thin section. The foundries are located in different cities covering a rather broad territory.

The associated foundries had for years enjoyed reputations for high grade work which made them regard each other as worthy competitors. Frequent contact in meetings of technical societies and in other ways resulted in exchange of experiences and friendly intercourse. The fact became apparent that ideals and business ethics of several competitors in the same field bore the same strong similarity as did process and product. This brought about natural respect and the implicit confidence that characterizes each group member toward his associates in the other companies, without which no such cooperative plan could succeed.

Competitors Co-operate

Before the world war several persons connected with the companies now holding membership in the Group discussed the advisability of doing cooperative research and thus accomplishing the desired improvement in manufacturing methods. It was recognized that the employment by one company of moderate size of a person of suitable qualifications for guiding such work, coupled with the other expenses incidental to some of the larger and more complex investigations that obviously should be carried on would involve a relatively large sum. The advantage of distributing such expense among a few companies producing the same kind of work added force to the argument that many problems are best solved by the combined wisdom of several investigators whose experience is gained from differing local conditions found in each plant of the same general type.

The outbreak of the war retarded the development of the idea. The great conflict made very heavy demands on the steel foundry industry and it was not until the summer of 1920 that the cooperative plan could be satisfactorily crystallized. The conditions regarding membership and general plan of operation considered essential were then satisfactorily met in the selection of the five associated companies, and of Major Bull as Research Director to coordinate technical activities and to devote his entire time to the solution of Group problems.

The Group has two guiding committees, one to decide questions of policy, finance, etc., and the other and more active one to determine technical procedure. The officers and principal operating officials of the companies are members of these committees. This permits decisions to be reached in committee conference without any delay in referring matters to principals. The executive committee generally meets every three months while the technical committee is usually assembled every six weeks. The meetings of both committees ordinarily extend over several days and permit the most thorough consideration of every problem under debate.

Central Office Controls Research in Plants

The Research Director maintains a central office without a laboratory and has a small office staff. All laboratory work is done at the group plants and in outside laboratories at times when results from other sources are desired to supplement the findings of Group laboratories. The Research Director spends a large amount of his time in visiting the plants.

Committee meetings of the Group are one of the few main heads under which the organized group work naturally divides itself. The meetings are technical conventions in miniature at which progress reports of investigations are read and freely discussed. These reports are prepared by the plant managers themselves. Following the discussion covering each investigation that is being prosecuted, agreement is reached concerning the steps that should next be taken to continue them. It is sometimes found desirable to transfer them to another plant to obtain the benefit of different local conditions. The progress reports of researches are mailed by the members to each other a few days in advance of the meetings to better permit intelligent discussion at the conferences.

Group investigations constitute the most important phase of cooperative work. Such a joint research is assigned to the plant which seems best fitted to conduct it from the standpoint of personnel and equipment. The plant manager himself is held responsible for carrying on a group investigation and in most cases has a large part in the actual work done. The Research Director gives such personal assistance in the prosecution of every joint investigation as he can and at all times keeps closely in touch with the progress of such work.

Scope of Researches

The researches conducted by the Group thus far include those relating to abrasives, annealing, core practice, facing sand, gas cutting, furnace practice, the elimination of slag from castings, and welding. Some of these investigations have already established important facts. Certain of the researches are of such a nature as to require much time for the solution of all the problems involved. A few investigations had to be suspended or modified in 1921 because business conditions interrupted the demand for certain classes of castings.

The visits of the Research Director to each plant are not alone for the purpose of assisting in group investigations. An important feature of such visits is a general inspection that is made, lasting several days, at which time constructive suggestions are offered concerning all phases of operations. During these inspections castings are critically examined to determine the thoroughness with which each group plant adheres to standards of inspection that have been agreed upon by the group members. Following these plant inspections, a written report is sent by the Director to the plant manager concerned and a copy of this is mailed to every plant in the Group. Any laxness in adherence to Group requirements is pointed out. Details of operations that may be of interest to the other Group plants are recorded.

Interchange of Data

One important feature of the group cooperating work consists of the interchange of technical data through the Research Director's office to which reports are regularly mailed by each plant. There reports are summarized for distribution to all the members at stated periods. They cover in great detail all the important phases of plant operations that are indicative of efficiency. They are often helpful in suggesting to a plant manager a research in his own plant. During the low production of 1921 these group reports were of considerable value in indicating possibilities for lower production costs.

Co-operation of Foremen

As the technical adviser of the associated companies, the Research Director endeavors to keep closely in touch with all technical developments that relate directly and indirectly to the production of steel castings. His office accordingly has become a clearing house of technical information which is being distributed constantly to the Group plants.

A feature of the Group work which has great value lies in the visits of the men on the technical staff of each plant to the foundries of the other associated companies. This interchange of visits has greatly broadened the perspective of the foremen; and has emphasized in the most important way comments made to plant subordinates regarding better methods followed in another plant. There have been frequent conferences of plant foremen in each of several operating departments who have been brought together at one plant to discuss among themselves possibilities of improvement in the operations in which these men are directly concerned. There has been vigorous effort to enlist the active interest of every Group foreman in the cooperative research work. The idea of improving shop practice by technical cooperation has been effectively sold to superintendents, foremen, and all others who have greater or less responsibility for the production of Group castings. The result is a belief in cooperating effort, which has been of pronounced aid to every plant manager.

After a little more than two years' work, the accomplishments may be summarized as folows:

1. Marked improvement in quality of product;
2. Considerable reduction in operating costs;
3. Formation the "research habit" in each plant organization;
4. Stimulation to do better work exhibited by all who have responsibilities in production.

The fact that the project is successful and had a sound basis is demonstrated by the enthusiasm for continuing the cooperation, exhibited by hardheaded business men who continued it with unabated zeal during a period when production was accompanied by considerable losses monthly.

PRODUCTION OF IRON AND STEEL OCTOBER 1922

The monthly report of the Dominion Bureau of Statistics states that the production of pig iron in Canada during October showed an increase of 11,914 gross tons or 47.7 per cent over record for September, and amounted to 36,888 tons as compared with 24,974 tons in the previous month. The increased tonnage was almost wholly basic pig iron manufactured for use by the firms reporting. The production of this grade increased from 16,976 tons in September to 28,922 tons in October or 70.4 p. c.

Although the October production showed an encouraging increase and was the greatest since March of this year when an output of 41,733 tons was reached, it was still below the monthly average for 1921.

During the ten months ending October, the average monthly production of pig iron was 31,287 tons this year as compared with a monthly average of 50,673 tons in the same period last year. The cumulative output was, correspondingly 312,877 tons in the past ten months as against 506,730 tons in the first ten months of 1921.

The number of active furnaces at the end of October was unchanged at four, viz: one at Sault Ste. Marie, one at Hamilton and two at Sydney.

The production of ferro-alloys remained practically same as in September at 1,823 tons comprised wholly of ferro-silicon of 15 to 80 per cent grades. Of this amount 68.6 per cent was of 15 per cent ferro-silicon.

The output of steel ingots and castings in Canada during October amounted to 52,735 gross tons, an increase of 47.3 per cent over the September production of 35,787 tons. Basic open hearth ingots produced for further use by the firms reporting amounted to 50,851 tons in October as compared with 33,815 tons in September an increase of 4.9 per cent from the average production for basic open hearth ingots during 1921 was 53,489 tons and for the first ten months of the current year averaged 37,-052 tons. The month of October therefore showed a decrease of 4. 9 per cent from the average production for 1921 and an increase of 37.2 per cent over the average for the first ten months of this year.

Basic open hearth castings made during the month amounted to 974 tons, an increase of 137 tons or 15.2 per cent over the preceding month, and most of the production was made for sale.

The output of bessemer castings declined slightly from 180 tons in September to 125 tons in October, a decrease of 30.6 per cent. Electric castings also fell off 10.6 per cent, the actual production being 831 tons in September and 743 tons in October.

The cumulative production of ingots and castings for the ten months of the current year amounted to 387,570 tons as compared with 594,792 for the same period of last year, a decrease of 29.5 per cent.

COST ACCOUNTING IN THE MANUFACTURE OF IRON AND STEEL SHEETS

The National Association of Cost Accountants has recently issued in official publication entitled "Cost Accounting in the Manufacture of Iron and Steel Sheets", by Mr. Keith B. Woods.

While the article is necessarily condensed, the author has endeavored to make the pamphlet a comprehensive outline of a system for obtaining accurate costs in an iron and steel foundry, together with all the mechanism leading up to it. To anyone reading this pamphlet carefully the general layout of almost any detailed system, whether steel sheets or not, is shown.

Among the many points brought out as resulting from the application of this system are the following:

1. There is practically no duplication of efforts, ,the original entry following right thru to the cost sheets without re-writing. An example of this is where the service card or order is used for the overhead on the cost sheets.
2. All cards are so laid out that the exact responsibility of each superintendent or foremen is shown.
3. The card of accounts is carried in the greatest detail but shown on most costs sheets in about nine

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This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the learned information.

items. Each one of the nine items can be quickly analyzed down to the requisition or labor card, etc., in its original entry.

4. Probably the greatest improvement over the ordinary sheet cost system is that the costs are mathematically correct as to different products and gauges. Sheets are sold by gauge or gauge differentials from a base gauge and finish differentials from a fixed product—One Pass Cold Rolled and Box Annealed Steel sheet-28 ga. In the system outlined great care has been taken to get the distribution of expenses on the correct basis for each kind of expense of every department both to other departments and to the product, and there is no averaging of gauges either on the cost sheets or thru the inventory to confuse the real cost and give one on the cost of sales that for a given period is practically meaningless, altho probably correct over a moderately long period.

Copies of this pamphlet may be procured from the office of the Secretary, National Association of Cost Accountants, 130W. 42 St., New York. The price to non-members of the Association is seventy-five cents per copy.

INDIA'S PRODUCTION AND IMPORTS OF IRON AND STEEL

In the neighborhood of 40 per cent of all iron and steel products shipped into India enter the Province of Bengal, which is the largest consumer of foreign iron and steel among the Provinces. Bengal heads the list with over 50 per cent in the receipt of most items, giving way to Bombay in hoops and strips, nails, rivets, and washers, scrap and cast pipes and fittings, and to Burma on wire nails and wrought tubes, pipes, and fittings.

The consumption of steel products in India is smallest during the monsoon season, which lasts from the 1st of June to the 1st of October, and merchants carry as small a stock as possible that is liable to rust or otherwise deteriorate during the rainy season. Orders, therefore, are not placed that will be delivered early in the monsoon season, and buying for delivery at the end of the monsoon usually commences about June 1st.

Consumption of iron and steel in India has not nearly regained its pre war volume and the potential market is large, but although American products have an excellent name in several of the Provinces their prices have placed them at a disadvantage. Quality counts very little in the Calcutta market; importers customarily buy the cheapest goods, being interested only in price. Foreign competition fortified by the high exchange value of the dollar has virtually eliminated American iron and steel from the markets of the Karachi district also.

As yet, India's production of iron and steel has had little effect on the market for imported products, but developments now in progress point to real competition from this quarter in the near future. The largest iron and steel company in India, the Tata Iron and Steel Works, is planning to enlarge its capacity by the end of 1923 to give an output of 650,000 tons of pig iron and 425,000 tons of finished steel annually, a large increase over its present capacity of approximately 300,000 tons of pig iron and 125,000 tons of finished steel. This firm claims that it is the only domestic producer of finished steel sections for the market in India at present. The Government has a small steel plant at Ichapore for the production of steel for ammunition and for Government purposes, but it is believed that none of this product is for sale in the market.

The Bengal Iron Co. (Ltd.) is said to be producing more than 150,000 tons of pig iron annually. It is expected that an annual output of 180,000 tons of pig iron will be reached by the Indian Iron and Steel Co. when its new works now in course of erection at Hirapur, Bengal, are completed. The proposition of erecting a modern steel plant with an output covering all basic steel products is being worked out, and a corporation for that purpose, the United Steel Corporation of Asia (Ltd.), is in process of flotation. Several small companies have iron works under construction.

The Mysore Government is putting up the money for the erection at Bhadravati, Shimoga district, Mysore, of iron works to have a capacity of 20,000 tons of charcoal pig iron. This works is to utilize ore found all around the plant site in the Bababudin hills. It is to be known as the Mysore Distillation and Iron Works and will be under the management of the Tata Iron and Steel Works—U. S Commerce Reports.

CO-OPERATION IN RESEARCH

The tendency for research to be a monopoly of the academician, or the physical chemist, cannot have failed to be noticed by all progressive foundrymen, states the *Foundry Trade Journal* in a recent issue. This state of affairs is due primarily to his special training, and secondarily to the precision apparati at his disposal. It does not follow that the results obtained from this class of work are of more value to the trades concerned than those given by the technical or even the practical man, because the highly-finished work of the research student is often a statement of facts, the propounders of which do not know or at least are afraid of giving their practical application. This was dealt with lately at the Swansea meeting of the Institute of Metals, by Sir Henry Fowler, who pleaded on behalf of the practical man to the newer schools of professors to indicate clearly the data capable of being translated by the departmental manager into actual practice. If a paper is without any practical interpretation then it might be so stated, so that the practical men associated with the various institutions can better occupy themselves by listening to a discussion from which there is little chance of their deriving any benefit beyond a lesson in the art of mutual congratulation. If real benefit is to be obtained by owners and managers from spending several days away from their works, then the councils of the various technical (not academical) societies should insist that the practical bearing of the papers must be clearly emphasised, or if the high-brows insist on arguing abstruse points, then perhaps it would be well to follow the American system and hold simultaneous meetings, so that those in charge of manufacturing processes will have a chance of eliciting and giving information helpful to the work in hand, and not something which might be useful in ten years' time. At this period, perhaps, it may be found that the research worker has so come down to earth that he is capable of successfully controlling manufacturing processes. At the moment, however, manufacturers prefer to employ technical men— men who should be capable of economically utilizing the results of published and their own research work through the medium of foremen, skilled men and labourers.

In some sections of the metallurgical industries well informed departmental managers are hesitating to give papers or contribute to discussions because of their lack of training in the higher branches of modern physics, and fear the criticism of those so versed. We can assure them that it is the absence of practical knowledge which re-

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(Continued).

strains the research worker from hazarding any application of his work to practice. Therefore the timidity is mutual.

The foundry trades can congratulate themselves that of all societies their representative technical association is the best in so far as catering for the actual workers is concerned, for when highly-scientific papers have been presented, the lecturers have been careful to point out the practical bearing.

No doubt, in the future, the Institution of British Foundrymen will accept a limited number of academical contributions, but we believe that before their advent a number of educational papers which have been and will be presented, will overcome the objection sometimes raised by the research worker "It is not our fault if managers are insufficiently educated to understand our investigations." Speaking for the foundry end of metallurgical industries, we feel sure that the intensive application of old-fashioned elementary chemistry, physics, and mathematics will do infinitely more good than any wild-cat chase into the realms of their higher branches.

There has been issued recently the first annual report of the British Cast-Iron Research Association, which was incorporated in June, 1921. British iron founders to the number of 202 were members of the association at the time of the report.

The association has made progress on the following researches: (1). Grading of pig-iron; (2) moulding sands and refractories; (3). motor-car and internal combustion engine cylinder castings; (4). alloys of cast iron for uniting erosion and corrosion, as in centrifugal pumps, ship pumps, dredgers, valves, pulverisers, etc.; (5). standardisation of testing methods for cast iron; (6). cupola and ladle linings; (7) abnormal fractures and structures in malleable castings; (8). shrinkage defects, "draws and shrink holes," in castings; (9). sulphur holes and hard spots in small castings.

By consultation with other bodies conducting researches of this sort, great care has been taken to avoid duplication of work already done or already under way. The co-operation of the American National Research Council has been very valuable in this connection.

To assist students working their way through Carnegie Institute of Technology, the Jones and Laughlin Steel Company, of Pittsburgh, has arranged to employ students in the steel mills on Friday and Saturday nights or all day Saturday. The shifts are of ten hours length. Jones and Laughlin is the first large concern in Pittsburgh to come to the aid of students in need of finances. The arrangement is pleasing to the administration at Carnegie Tech. because of the opportunity it gives to the students in the College of Engineering to acquire practical as well as theoretical knowledge.